THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 39. Thursday, August 16, 1928. No. 626.

PUBLISHED WEEKLY

Subscription Terms: 15s. per annum.
Foreign and Colonial, 17s. 6d. per annum.
All Subscriptions are payable in advance.

All Communications to be addressed to the Editor, or to the Publisher, as the case may be, of

THE FOUNDRY TRADE JOURNAL,
49, WELLINGTON STREET, LONDON, W.C.2.

Telephone: Gerrard 3961 (4 lines).
Telegraphic Address: "Zacatecas, Rand, London."

Contents.

	PAGE
An Apprenticeship Inquiry	105
From the Haphazard to Orderliness	105
Study of Shrinkage in an Iron Casting	106
American Foundrymen's Association	106
Random Shots	106
Worthington-Simpson Foundry, Newark-on-Trent	107
Harvey Engineering Works	108
Correspondence	108
The Laboratory at Stanton Ironworks	109
Electric Furnace Company Re-organisation	110
The Moulding of Bath Tubs by the Jar Ramming Method	111
Critical Points and the Martensitic Quench in Ni and Ni-Cr Cast Iron	112
General Characteristics of Alloy Steel Castings	113
Death of Mr. William Wolfe	114
Copper *versus* Lead—The Roofing Problem	114
Manganese Steel	115
The Relation between Silicon Contents and Thickness of Iron Castings	116
Personal	116
Notes on the Routine Analysis of Cast Irons and Iron Foundry Raw Materials—No. 1	117
German Ironfounders' Employers' Federation	118
Theory or Practice in the Grey Iron Foundry	120
Trade Talk	122
Obituary	122
Company Meetings	122
New Companies	122
Contract Open	122
Book Review	124
Iron and Steel Markets	124

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

Institute of British Foundrymen.
PRESIDENT: 1928-29:
S. H. Russell, Bath Lane, Leicester.

LIST OF SECRETARIES—

General Secretary: T. Makemson, Saint John Street Chambers, Deansgate, Manchester. London Office, 49, Wellington Street, London, W.C.2.
Birmingham: F. K. Neath, 24, St. Paul's Square, Birmingham.
Sheffield: T. R. Walker, 26, Castlewood Road, Fulwood, Sheffield.
Scottish: J. Bell, 60, St. Enoch Square, Glasgow.
Lancashire: H. Stead, 1st/36, Cheetham Hill Road, Stalybridge, Cheshire.
London: H. G. Sommerfield, Charterhouse Chambers, Charterhouse Square, London, E.C.1.
Newcastle-on-Tyne: F. Sanderson, 10, Westgate Road, Newcastle-on-Tyne.
East Midlands: H. Bunting, 82, Otter Street, Derby.
West Riding of Yorkshire Branch: S. W. Wise, 110, Pullan Avenue, Eccleshill, Bradford.
Wales and Monmouth Branch: J. J. McClelland, M.I.Mech.E., Druslyn, Bishops Road, Whitechurch, Glam.
Middlesbrough: N. D. Ridsdale, 3, Wilson Street, Middlesbrough.

Foundry Trades Equipment & Supplies Association.
President: H. Winterton,
Kelvinvale Mills, Maryhill, Glasgow.
Secretary: K. S. Bridges, Avenue Chambers, Southampton Row, London, W.C.1.

Welsh Engineers' and Founders' Association
Secretary: F. J. Griffiths, 20, Fisher Street, Swansea.

BRITISH CAST IRON RESEARCH ASSOCIATION.
The Registered Office and Laboratories of the B.C.I.R.A. are at:—
24, ST. PAUL'S SQUARE, BIRMINGHAM.
Telephone: Central 1885. Telegrams: CIRA.
The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk (*Telephone 33*).

An Apprenticeship Inquiry.

We make no apologies for reverting once more to the question of apprenticeship and training, which is of such great importance to the founding industries. A number of inquiries on it are now coming to a head.

The Ministry of Labour has just completed an inquiry lasting over three years into the training of boys and girls for skilled occupations. Six reports have been issued dealing with specific groups of industries, and a general report has now been completed. These reports represent an attempt to get at facts without any attempt to make recommendations. Some 44,000 employers, about two-thirds of the total approached, responded to the request for information, as well as many trade associations.

It appears that about one-third of the boys in training serving as apprentices still serve under written agreements, but the bulk of the remainder under verbal agreements only. In those industries in which apprenticeship or learnership occur one-fifth of the male workpeople under 21 are apprentices and nearly one-third are either apprenticed or employed under some form of training which is the modern equivalent of apprenticeship.

The general report just issued brings out the unexpected fact that the small firm in relation to its size does more for apprentice training than the large firm, although this is, of course, subject to some notable exceptions.

The commonest method of choice of apprentices is selection by personal interview followed by a preliminary trial or probationary period. The usual method of training is still that of attachment to a skilled workman.

One of the most illuminating facts disclosed is the change in the traditional seven-year apprenticeship. The majority of boys are on a five-year apprenticeship starting at 16. This gives a great argument to those who desire the school leaving age to be raised, because the impressionable years 14 to 16 are much too important to waste in odd jobs while waiting to commence apprenticeship.

In this as in other similar inquiries it is difficult to ascertain the exact position of the founding industry because it is impossible to say whether the industry is being treated as an integral part of the engineering industry or as part of the iron and steel industry. It is probable that the foundries in each section are treated as belonging to that section, but even then the independent foundries are not located. The report attempts to estimate the number of journeymen to each apprentice or learner and the number necessary to maintain the existing strength. The number of moulders and coremakers per apprentice is given as 4.0 and the number of patternmakers as 3.5. There seems to be a wastage of some 10 per cent. who do not complete their courses. Assuming, as anybody is bound to assume, that entry to the trade can only take place through some definite scheme of apprenticeship, the report concludes that the present proportion of apprentices may "result in an actual diminution of journeymen moulders." Here then is actual and ascertained statistical fact from an official and unexpected source which is in support of the feeling behind the recent educational movements in the trade. No further justification for these is necessary. If this conclusion is true for the present state of the trade, what is going to be the position when the trade gets really brisk? Every employer who is working for the better times must bear in mind the great difficulties always to be associated with a shortage of skilled men.

From the Haphazard to Orderliness.

A new and interesting phase of business methods has recently been given prominence in the American Press. It relates to the reception of commercial representatives. Candidly, the position in Great Britain is unsatisfactory, as in general only the following types can be definitely assured of a proper reception:— (1) A foreigner representing a foreign firm, and (2) a traveller who has already made friendly contact with the buyer or a departmental executive. Whilst different yet serious motives actuate these two cases, being, respectively, curiosity and confidence, they afford pointers as to why all callers should be given an opportunity of presenting their cases. The firm referred to in the American Press, fully recognising the importance of this under-studied business activity, has prepared a series of notices to be prominently displayed in the room where visitors are received. They intimate that all callers will be seen as expeditiously as possible; that complaints of dilatoriness are to be reported; that courtesy demands that each caller should take his turn. Moreover, the number of travellers interviewed last week and the average time accorded to each is strikingly brought before the notice of the visitor. This serves as a polite reminder that whilst the firm is according every possible facility to the commercial representative, it is a privilege which, in the interest of all, must not be abused.

We sometimes feel that the buyer and his staff should act as a filter, allowing those visitors possessing real technical knowledge to be interviewed by a suitable member of the technical staff, otherwise ignorance of applied science may involve serious mistakes; whilst the buyer should and does possess an intense knowledge of his raw material markets, and may have found the information given by a salesman reliable, yet a talk with the technical staff will often disclose economies unable to be evaluated in price fluctuations. In arranging any scheme for dealing with visitors, two cardinal points should be borne in mind. Primarily, salesmen should be accorded a reception equal to that the buyer would wish to be given to his firm's representatives, and, secondly, a large percentage of the men on the road are high-class, technically-trained specialists, who are in a position to help materially the departmental managers.

XUM

Study of Shrinkage in an Iron Casting.*

Since the publication of this Paper we have received three important contributions to the discussion, which we print below.

Dr. A. L. Norbury wrote that he thought the author was to be congratulated on his very valuable Paper. Mr. Servais had set out to solve a certain shrinkage problem, and had done so in a very conclusive and instructive manner. It would have been useful, however, if the author could have given some information regarding the composition of the grey iron; the way it was melted; the pouring temperatures, and so on. He would, however, like to know if there were any signs of chill or white iron at the corners of any of the square test-bars. A considerable amount of data has been accumulated by the British Cast Iron Research Association on the effect of variations in composition, *e.g.*, of carbon, silicon, manganese, phosphorus and sulphur on the solid shrinkage of round test-bars of different diameters. They find, as is well known, that white bars shrink more than grey bars, and that thin grey bars shrink more than thick grey bars of the same composition, and that ordinary variations in chemical composition have little effect on the shrinkage, except in so far as they make an iron white or grey. He thought it had sometimes been assumed that the reason a thick grey bar shrank less than a thin grey bar was on account of a greater graphite content in the thick bar. This, however, was not the explanation, since less shrinkage was found in a thick grey bar than in a thin grey bar of the same chemical composition and graphite content. He would like to know if the author agreed with the following explanation, that in a thick bar the shrinkage of the outside of the bar is affected and lessened consequent on the later solidification and shrinkage of the inside of the bar in a somewhat similar manner to that shown in the author's tests. It was hoped that the author will follow up his very instructive Paper with further investigations of a similar nature.

Mr. Arthur Logan wrote that he regarded this as a very interesting Paper, because it formed an introduction to a subject about which very little was known. He would suggest that a more correct title for this Paper would be "Study of Differential Shrinkage in an Iron Casting." This question of the differential shrinkage in a casting was coming more to the fore every year, due to the increasingly intricate and difficult castings demanded by modern engineering, and Diesel engines in particular. The whole question of shrinkage was really bound up with design, because although a casting of uniform section and design might have as much shrinkage as another casting of unequal sections, yet in the one case the casting would solidify harmlessly as a whole; whilst in the other the rapid solidification of certain parts might prevent the full shrinkage of other parts, with the result that local internal stresses, often of a severe nature, were set up.

He would like to make one practical suggestion to the author which might be of use in future work on this problem. In an investigation into the causes of failure of certain castings which were admittedly of bad design from the contraction stresses point of view, certain experimental castings were designed and made. These were carefully gauged, then a portion which acted as a tie bar was cut through, resulting, as was expected, in a change of dimension. This change of dimension was not only accurately measured, but it was possible to measure the actual stress previously existing, by putting just sufficient load on to bring the casting back to the original gauge size.

Whilst this Paper only touched the fringe of the subject it would be very interesting if the author, or others interested, would pursue this investigation, and provide more information on this very important subject.

Mr. J. Shaw wrote that after reading this interesting Paper giving the divergent views of two well-known French metallurgists, one wonders why no note had been made of a very valuable Paper on the subject by C. Heggie, printed in the I.B.F. proceedings for 1914-15, page 66. From this Paper the point at issue could have been settled at once. The investigation was carried out on much more scientific lines by means of extensometer curves, and those points noted first by each size bar separately and afterwards from the thick and thin bars in two frames cast together. The above is another illustration of duplication of work owing to the lack of a proper summary of all Papers on a given subject.

* By Maurice Servais, presented to the Leicester Conference of the Institute of British Foundrymen.

American Foundrymen's Association.

At the annual meeting of the Board of Directors of the American Foundrymen's Association held in Chicago the Board voted unanimously in favour of holding the 1929 Convention at the Stevens Hotel, Chicago, the week of April 8, and to hold in conjunction therewith, in the Exhibition Hall of the hotel, a non-operating, limited space exhibit.

The Hotel Stevens, the world's largest hotel, with over 3,000 rooms, will make possible accommodating practically all visitors in the same building where meetings will be held and exhibits installed.

Research in Cast Iron.

The report of the Committee on Grey Iron Castings, recommending a programme of joint research in cast iron, the A.F.A. co-operating with the Engineering Foundation, the Grey Iron Institute and others, was considered and referred to a committee of three to make further investigation, this committee to report to the Board or to the Executive Committee.

The Board authorised the appointment of a committee of five, representing various branches of the industry, to determine policies of the A.F.A. regarding research and appropriations for that purpose.

Cost Committee Recommendations Approved.

The following recommendations of the Cost Committee adopted at the cost session of the Philadelphia Convention were approved by the Board:—

1. Recognition by the A.F.A. of the uniform cost system of the 'Steel Founders' Society of America and recommend its use in all steel foundries.

2. Recognition by the A.F.A. of the uniform cost system of the Malleable Iron Research Institute and recommend its use in all malleable foundries.

3. That the A.F.A. encourage the Grey Iron Institute to develop a uniform cost system for grey-iron foundries.

4. That the A.F.A. encourage the organisation of a representative group of non-ferrous foundries for the purpose of developing a uniform cost system for non-ferrous foundries.

Uniform Trade Customs for Foundries.

In response to requests received from a number of sources, the Board authorised the appointment of a committee to consider the advisability of sponsoring a joint committee to draft uniform trade customs for the casting industry, said committee to report at the next Board meeting.

Following the adoption of resolutions of appreciation for services of retiring directors Jesse L. Jones and Herbert S. Simpson, and to Stuart Wells Utley for efficient and faithful services rendered during his two years as President of the Association, the meeting of the old Board was adjourned and the meeting of the new Board called to order with President S. T. Johnston in the chair.

The Board was organised by re-electing C. E. Hoyt Executive Secretary-Treasurer and Manager of Exhibits, R. E. Kennedy, Technical Secretary, and electing directors S. W. Utley, A. B. Root, Jr., S. C. Vessey and A. E. Hageboeck to serve with the President, Vice-President and Executive Secretary as members of the Executive Committee.

The resignation of Mr. W. D. Goldsmith as a director was accepted and in accordance with the provisions of the By-Laws the Board filled the vacancy by electing H. Cole Estep, of the Penton Publishing Company and Chairman of the Committee on International Relations, as a director.

Random Shots.

The detailed programme of the Liverpool meeting of Institute of Metals has now been published and deserves a little comment. The first point that strikes me is that here is another institution declaring its adherence to the principle of a separate ladies' programme at its conference. It appears that many of the ladies whose interest in the technical business of the meeting is, shall we say, rather indirect, have been apt to find the mornings in particular very hard to occupy in an unfamiliar town. . . . But what a commentary upon the growing desire and ability of women to share all male pursuits and interests!

* * *

Once granted your ladies' programme, here is the same phenomenon to which I called attention at the time of the Leicester Convention! What are the ladies to be shown? The process of dyeing, the manufacture of biscuits, the manufacture of matches. All calculated to appeal to, the supposed domestic nature of the female! I began to feel that those responsible for these arrangements really must have a keener appreciation of feminine psychology than I, since there have been no signs of support for my feeble voice crying in the wilderness. Is there not a likelihood of our wives and daughters being interested in the things that interest us? How many wives have yearned to know the difference between a mould and a corebox?

* * *

Incidentally, speaking of the manufacture of matches, I can still remember my first acquaintance with repetition processes on a large scale in an important match factory in London. I recall standing amazed at the dexterity with which the girls boxed the matches as they passed on a moving belt; the occasional spurts of flame and their extraordinarily prompt extinction; the curiously heavy atmosphere slightly redolent of phosphorus that prevailed, in spite of heroic efforts at cleanliness and ventilation. I have seen many repetitive processes since then, and if I had to choose one for a livelihood it would be bottling Bovril or coating chocolate any day in preference to any hand in the production of the commonplace box of matches.

* * *

I have come to the conclusion from various items of news that have filtered my way that Germany and Central Europe exercise a strong attraction for holiday purposes, not merely over "he that meddles with cast iron," but over all whose work concerns metals. I have heard lately of so many ferrous and non-ferrous lights who have holidayed or who are holidaying in those parts that I wonder what the attraction is? Of course, we all know that the Germans are particularly well up in matters metallurgical, but even the most conscientious of us does not as a rule plan his holiday for such reasons. Perhaps it goes deeper. Perhaps the country of gnomes and kobalds and underground mysteries of faerie metal-working exerts an inevitable attraction over their modern prototypes. . . . Or, again, is it the excellence of the wines of the Rhine and Moselle? Although it is absurd to suppose that either wine or beer would influence founders in the choice of a holiday.

* * *

Of course truth is that Germany, Austria and the Tyrol are only just coming into their own for holiday purposes. Before the war it was the few who went abroad for their annual holiday. Nowadays it is the many, and the change came about in those post-Armageddon years, when the Teutonic countries were unlikely to prove physically or spiritually comfortable for the Anglo-Saxon. So Belgium has been overrun with English tourists; the coast of Picardy differs little from the coast of Sussex: and all over Switzerland, France and Italy the voice of the English is heard in the land. To-day, fortunately, people are realising that there are wider fields at their disposal, and the generation that was taught no German at school may yet live to find Latin an inadequate substitute.

Marksman.

Worthington-Simpson Foundry, Newark-on-Trent.

During the past twelve months the foundry at the Newark Works of Messrs. Worthington-Simpson, Limited, has been completely reorganised. Much of the plant, which was well in line with the best modern practice, has been retained, but the whole has been entirely rearranged on modern lines, so that man-handling is reduced to a minimum, a natural outcome of which is a higher all-round efficiency and an increased output. The quality of work is of the highest standard, and varies from small intricate cored castings for pumps, etc., handling a few gallons, to large machines dealing with five million gallons per hour. Large condensing machinery and steam engines are a speciality with castings weighing up to forty tons. Special high-tensile iron for Diesel engines, etc., is produced in large quantities.

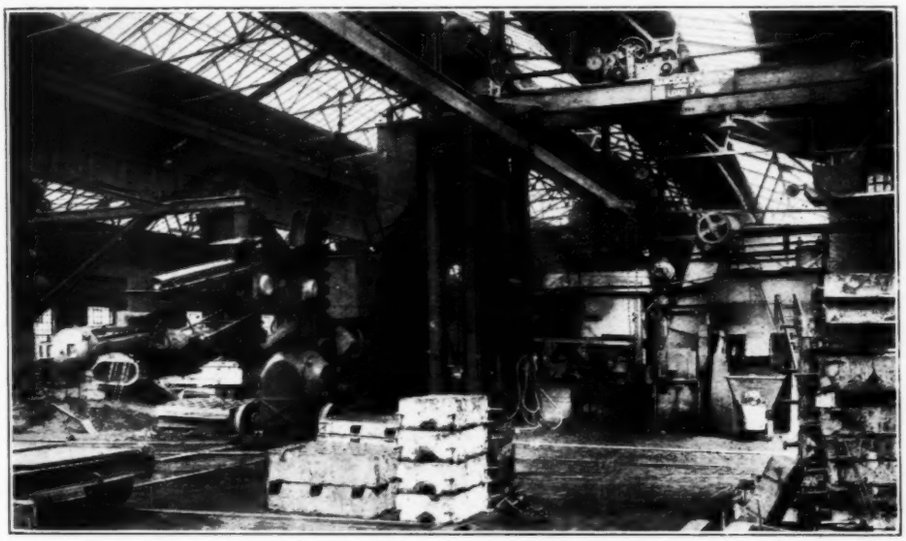


Fig. 1.—Sand Slinger Receiving Sand from an Elevated Hopper. The Cleaning, Sifting and Milling Plant is shown on the Right.

Not so many years ago foundries in general gave very little consideration to the sand-mixing plants; costs were none too carefully kept, and so long as the moulders received the necessary supply of sand and did not complain too much regarding the quality, the plant was allowed to carry on. The cost of its inefficiency could not be appreciated because it was seldom known with any degree of accuracy. It is generally recognised in foundry practice that a high degree of overall efficiency in the foundry must start with and indeed be governed in a surprising degree by the efficiency of the sand-mixing and sand-handling plant. Obviously no rule-of-thumb method can be adopted, and it would seldom be possible to adopt the same system in any two foundries. Foundry engineers, however, are fully alive to this fact, and each case is treated on its merits; thus at every modern foundry the sand-mixing and handling plant possesses features special to itself, which, however, are of general interest.

Drying stoves are another auxiliary of the foundry, in the construction of which revolutionary changes have been made during the past few years to render their operation more mechanical, and consequently to give a more uniform production and at the same time reduce so far as possible fuel consumption.

When the rearrangement of the Newark Foundry was taken in hand, the management very wisely decided to scrap the whole of the existing sand-mixing and handling plant, as also the whole of the drying stoves, and, as will be seen from our description, the units installed in their stead are at least equal to any plants of a like character either in the United Kingdom or on the Continent.

The foundry is covered by one main bay 625 ft. long × 45 ft. wide, the runways carrying three cranes of respectively 40 tons, 30 tons and 20 tons capacity. There are also two side bays each 26 ft. wide, one of them housing the stoves and cupolas. The machines installed comprise hand machines by the Adaptable Moulding Machine Company, and a number of Ajax jolt-ramming machines. One end of the foundry is laid off for loam and the opposite end for sand castings, whilst casting is done in the mid-position, *i.e.*, adjacent to the cupolas and stoves. A sand-slinger (Foundry Plant & Machinery, Limited, Glasgow) travels a 220-ft. length of track, and is capable of working in a radius of 35 ft.; that is, the ramming unit has a radius of 17 ft. 6 in. from the centre of the track. This machine is the largest of the type installed in Great Britain. The ramming unit may be operated at 4 ft. 6 in. to 7 ft. 6 in. from floor level, whilst the impeller motor fitted is capable of ramming the heaviest type of moulds. The machine hopper carries 200 cub. ft. of sand, which is fed regularly by slat bottom to the shaker riddle at the boot of the elevator. The machine is travelled by a 15-b.h.p. motor, whilst the impeller is driven by a 12½ b.h.p. motor, the elevator and hopper bottom by a 7½-b.h.p. motor; the arm-raising gear and belt conveyor are each driven by a 4-b.h.p. motor. This machine rams 6 cub. ft. of sand per minute.

Sand-Mixing Plant.

Castings are stripped in the centre of the shop immediately adjacent to the sand plant, and the sand is discharged to the boot of an elevator, which feeds over a magnetic separator (Rapid Magnetting Machine Company, Limited) into a 10-ton elevated hopper. This hopper terminates in a "breeches" shute, with valve-controlled openings right and left so as to feed the two Simpson intensive mixers (August's Muffle Furnaces, Limited). By way of the shutes the sand is fed into the bucket-loader, which is attached to each mixer. Each of these bucket-loaders holds 5 cwts. of sand, and the charges make up the normal charge of 10 cwts. in the mixer. Approximately 10 per cent of new sand is added to the used sand in the bucket-loader for facing. The charge is delivered into the mixer as it is operating. A water spray fixed above enables the operator to supply the correct amount of water to the sand, and at the end of three minutes the 10 cwts. of mixed and reconditioned sand are ejected through the discharge door of the mixer directly into the August patent aerator, which is fitted as an integral part of the mixer in the discharge shute. This aerator consists of a metal drum, bearing serrated steel blades, which fits snugly into the discharge shute of the mixer, and which, being driven from the main shaft, is in operation during the whole of the working time of the mixer.

The elevator and conveyor are driven by a 4-h.p. motor, the mills and loading buckets by a 15-h.p. motor. The elevator, conveyor, hopper

Fig. 2.—Sand Slinger in Operation.

XUM

and other constructional work in connection with the mixing plant was carried out by the New Conveyor Company, Limited, Smethwick, Staffs.

Although a very large output of mixed and reconditioned sand is obtained—20 tons per hour from the two mixers—these are only in operation for about an hour each mixing facing sand. One man easily operates the two units, and his work only consists of opening the valves on the hopper discharge shute, moving the controls to lift the bucket-loader, adding the requisite water by turning the water valves, and moving the lever to open the discharge door of the mixer. The main portion of the sand used for backing purposes does not pass through the mills but is sifted, separated and cleaned; it is then elevated to another hopper having a capacity of 10 tons whence it is discharged direct to the sand-slinger hopper; up to 100 tons of sand per day can be handled.

Whilst the plant ensures an absolute standard and uniform temper, fineness and condition of the sand, the centralisation has rendered available for moulding purposes a large area of floor space which was previously required for sand dumps. Each mixer supplies its respective end of the foundry, the sand being conveyed from the mixer by Hudson tipping buckets. The sand-slinger travels under its own power to the sand plant and takes its supply direct from the overhead hopper.

The melting-plant cupolas comprise a 12-ton Evans, a 7-ton Whiting, and a 3-ton Evans. The charging platform is served by a double-cage, electric hoist and blast is supplied by Keith-Blackman fans; the blast mains are interconnected so that the blowing plant is common to all three cupolas.

The Stoves.

The core-drying plant consists of four August core stoves each 6 ft. 4½ in. wide × 7 ft. high × 8 ft. long. This plant is arranged in the core shop, which is apart from the foundry. The battery has a common underground firebox placed outside the building, and the stoves operate on the August well-known rack-and-conveyor system, *i.e.*, a steel rack with adjustable shelves is placed in such a position that the core-makers, with a minimum of exertion and without leaving their bench, deposit their cores, as made, on the shelves of the rack. When the rack is full the conveyor is placed beneath, the rack elevated slightly, and the conveyor thence moves along from this position into the stove.

The August system of stove heating consists, as is now well known, of blowing hot dry air from an incandescent coke fire into the stove at floor level, and after circulating completely through the stove it is exhausted to the chimney at floor level.

There are three August mould-drying stoves each 15 ft. 4 in. wide × 10 ft. 6 in. high × 25 ft. long. The system of firing is similar to that of the core stoves. In this case a three-point recording pyrometer is fixed to enable the temperature of each stove to be seen and a constant record kept. These records are a check upon the efficiency of the men, and have been responsible for considerable economies in fuel. A working temperature of 315 deg. C. is maintained, and the arrangement of the dampers is such that when the fire is out a temperature of 105 deg. C. can be held in the stove for a considerable time.

Each stove has a ball and V-track running into it, along which operate the heavy girder bogies upon which the charge of moulds is formed during the day and drawn into the stove for drying during the night.

An August portable mould dryer is also in service. The body of this dryer is of sheet metal lined with firebricks in such a way that an incandescent bed of coke provides a heating surface over which is flowing a large volume of air provided by a motor-driven fan fitted to the casing. This dryer is of the simplest possible form, entirely free from mechanical complications. The temperature and quantity of the hot air are of easy regulation.

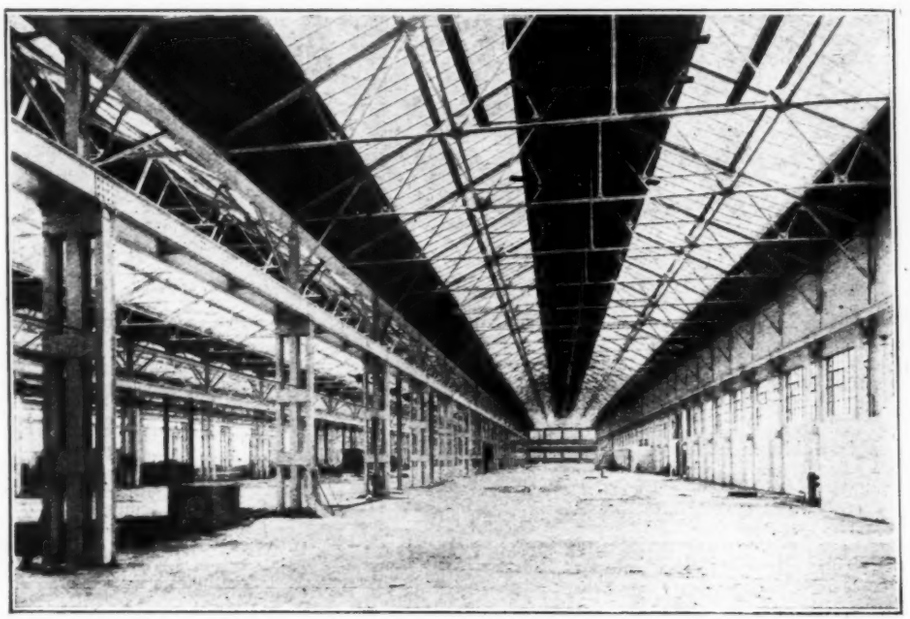
In the fettling shop there is a Tilghman's sand-blast machine; no pneumatic tools are, however, in service.

No alteration has been made in the brass foundry, the equipment of which is quite modern. The melting plant consists of one each 20-cwt., 15-cwt. and 5-cwt. coke-fired tilting furnaces by British Reverberatory Furnaces, Limited; two small machines are in service, but for the most part heavy castings are produced.

Harvey Engineering Works.

Important Extension.

During the last few years we have heard a good deal about foreign competition and the depression in the British engineering and metal-working industries. There is, however, evidence that, in spite of this competition, some at least of our more enterprising engineering firms have not only maintained their hold on the home and overseas markets, but are doing bigger business than ever. This gratifying result has been achieved mainly by the adoption of new and improved methods of production together with a bold policy of expansion.



View of One of the Bays in the Extension Building at the Works of G. A. Harvey & Company (London), Limited.

Among the firms who may be placed in this category are Messrs. G. A. Harvey & Company (London), Limited, of Woolwich Road, London, S.E.7. This well-known firm, whose works cover an area of about 25 acres, was established in 1874. It has one of the largest and best-equipped plants in the kingdom for the economical production of mild-steel plate and wire work of every description. Harvey's specialise particularly in heavy perforated metal and woven wire for screening stone, ore, sand, gravel, coal, coke, etc. These screens are supplied in a large variety of standard patterns, weights, and gauges, and the firm undertakes to work to any specification.

The increasing demand for "Harvey" products has necessitated a large extension of the works to keep pace with this demand. A new building, with a floor space of over 100,000 sq. ft., has just been completed, and plant of the latest type is shortly to be installed for the production of sheet-metal work on a largely increased scale.

The new structure, which is brick built, and roofed with glass and corrugated asbestos sheets, is 500 ft. long, 250 ft. wide, and 38 ft. high. The floor area is divided into four bays, each over 60 ft. wide, running the entire length of the building. S. H. Heywood electric cranes, ranging from 5 to 10 tons' lifting capacity, have been installed in each bay.

This new addition to Harvey's plant will add considerably to their capacity for production on the most economical and efficient lines, and will give employment to 500 or 600 additional people.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Who Discovered Oil Sand Cores?

To the Editor of The Foundry Trade Journal.

Sir,—The development in the application of oil sand mixtures to the production of cores and moulds has reached a pinnacle of considerable importance in the foundry industry. From many points of view the perfection attained in the use of this material may be regarded as one of the most outstanding items of foundry progress during the past twenty-five years. It therefore becomes a matter of considerable historical interest to ascertain whether the introduction of the use of oil sand mixtures can be ascribed to any particular individual. Failing this, it would be of equal importance to trace the earliest date of the application of oil mixtures for mould and coremaking. Perhaps some of your readers would be able to help.—Yours, etc.,

Your Metallurgical Correspondent.

[Our Correspondent raises an interesting point, and one version of its first application in Great Britain is the following:—The late Mr. C. Morehead, then engaged with Messrs. Willans & Robinson, of Rugby, was having difficulty with the manufacture of petrol-engine cylinders, and heard of a remarkable mixture being used in a steel foundry in Belgium. He visited the foundry and paid £100 for the formula. This enabled him successfully to cast motor-car cylinders. Later, he joined Henry Watson, of Walker Gate, and took his formula with him. Here Ismays, a Newcastle firm of chemical manufacturers, now non-existent, made up the material. When Ismays went out of business, the manager handling the core oil took the business over the river to Gateshead, where it is still made and sold through Alfred Herbert, Limited, of Coventry. This is one story, but we are constantly meeting with other claims, some of which at least seem authentic.—Editor.]

Big Foundry Contract for Stanton.—The Stanton Ironworks Company, Limited, near Nottingham, have obtained the contract for 10,000 tons of cast-iron pipes for the Buenos Aires water undertaking. This is the first contract of any importance obtained from this Argentine authority since the war for cast-iron pipes, and the contract has been obtained in the face of severe competition from foreign makers.

The Laboratory at Stanton Ironworks.

When we consider the important part which the metallurgical chemist plays in our manufacturing industries it is remarkable how very little consideration, generally speaking, is given to the disposition and equipment of the laboratory at iron and steel works, more particularly perhaps the first named. For the most part the disposition of the laboratory is not determined by the suitability of the site, but is placed where space can be found for its accommodation. The amount of useful work done by the metallurgical chemist in a laboratory where he is cramped for room, badly lighted, and equipped with the barest necessities, is really wonderful. The value of the work is recognised; surely therefore it is bad policy and really false economy to expect that work to be carried out under conditions of discomfort.

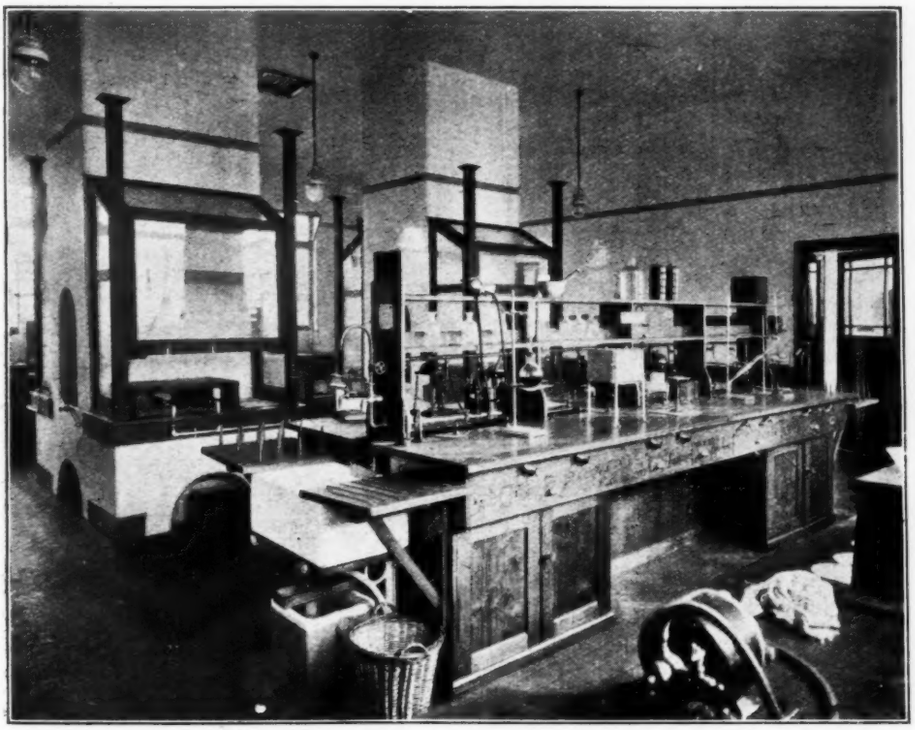


Fig. 1.—General View in the Main Laboratory.

With restricted space and more or less indifferent equipment the staff are kept fully occupied with routine work; they have no time and possibly less facilities for research. The inestimable value of this last is thus lost to the works concerned and they must perforce rely upon outside assistance. We do not wish to detract in any way from the value of independent research, but surely the capable metallurgist with an intimate knowledge of and in close touch with the practice of a particular works is in the best position to conduct research in the channels likely to prove of most use to his company. Unfortunately one cannot commercialise metallurgical research; it is not directly productive, but it is equally certain that it must not be regarded as a dead charge.

In view of the foregoing the following description of the laboratory which has recently been built and equipped adjacent to the new furnaces of the Stanton Ironworks Company, Limited, is particularly interesting, representing as it does the very best modern practice in layout and equipment. Mr. Woodhouse (chief chemist to the Stanton Company) deserves to be congratulated upon his acquisition. The laboratory is housed in a building entirely by itself and the grounds surrounding it are laid out with flowering shrubs, trees and roses. The building is 86 ft. 6 in. long × 30 ft. wide, and, as will be seen from our plan, is divided up into a number of rooms, which are equipped with the necessary apparatus for carrying out accurately and expeditiously the various analyses and tests required by the departments which the laboratory serves. Heating is by hot-water radiators which are fitted round the rooms and corridors. The rooms are ventilated by means of a motor-driven fan situated in the roof and connected to each room by an acid-proof metal air duct.

A Well-Equipped Sampling Room.

In the sampling room there is a Sturtevant automatic sampler, together with a Sturtevant grinding machine. These are used for sampling fuels. Also there are an emery wheel, drill, hack saw, etc., for taking metal samples. Bucking boards set in concrete foundations serve for sampling ironstones, slags, limestones and any other materials requiring crushing. A bench also is fitted up here for testing the pyrometers used at the furnaces and foundries.

The main laboratory is a room 30 ft. × 27 ft. 3 in., the walls of which are lined with white tiles, as also are the fume chambers and muffle chambers. The muffles are of two types—gas and electric. The fume chambers are a special feature. The chimney leading from them is 30 ft. high, and the waste heat going into this chimney from the gas muffles creates an extra draft on the fume chambers, rendering them very efficient. Another feature in the laboratory is the special bench for titrations. This bench is fitted with

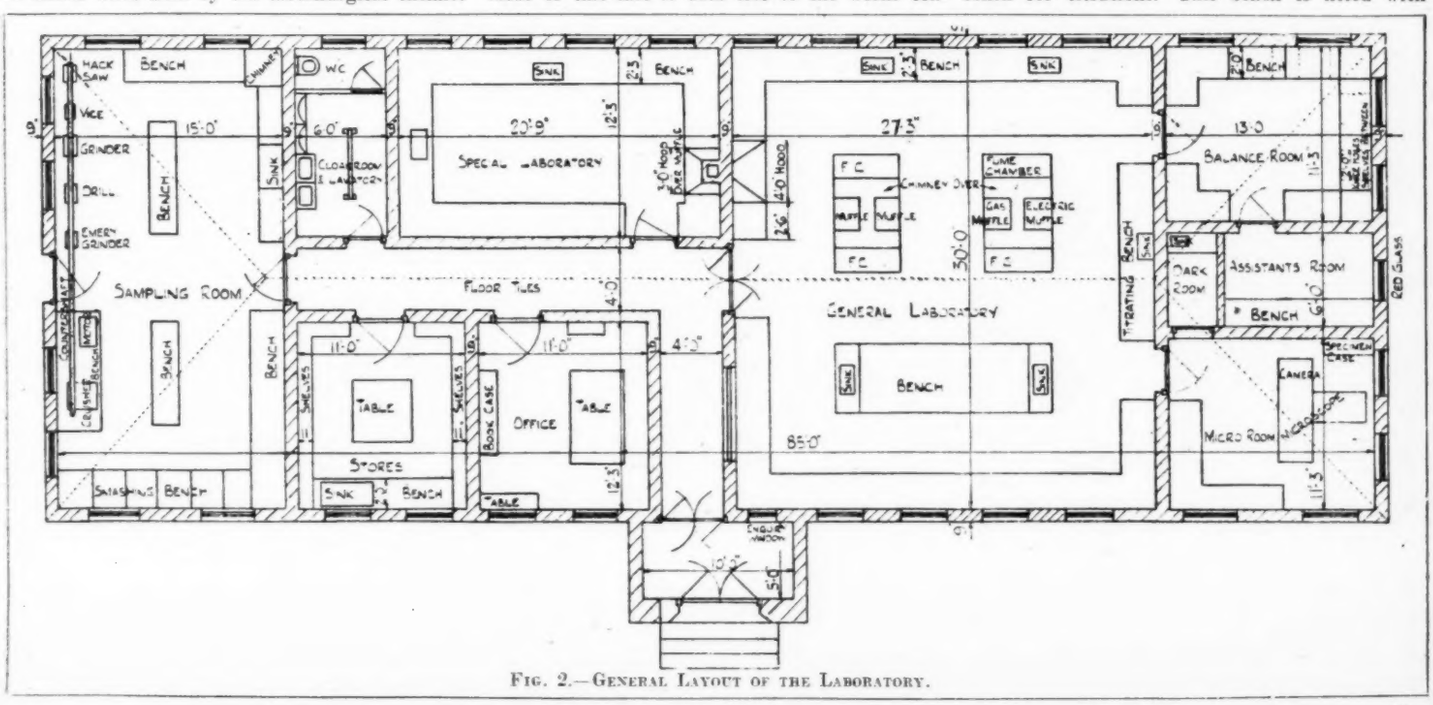


Fig. 2.—General Layout of the Laboratory.

opal glass let into the bench, and two partitions of this glass are illuminated from underneath by electric bulbs, thus giving an exceedingly good light through the liquids when titrations with special colour end-points are being carried out. The burettes are held in clips, which are suspended on brackets fixed to the wall and made to move in any desired direction. It may be noted that this laboratory is fitted with water, gas, electricity, blast, vacuum and steam.

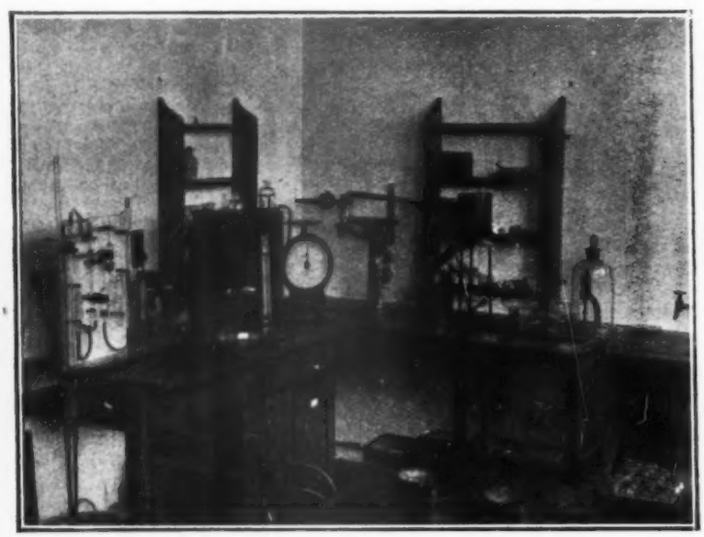


Fig. 3.—A Corner Devoted to Gas Analysis Cement Testing.

Fig. 4.—Combustion Bench for Carbon Determination.

In addition to the routine testing at the blast furnaces and foundries, special apparatus is installed for testing of bitumen for road materials, coatings for pipes, lubricating oils, tars and many other products. Leading out of the general laboratory on the north side are the balance room, and on the south side the micro room and photographic room. The balance room is fitted up with four Oertling balances, two Bungé balances, and two Becker balances. Special racks are provided for each assistant to keep his samples in.

The micro room is equipped with a Watson metallurgical micros cope and camera, and magnifications up to 1,500 can be obtained. There is also the necessary equipment for preparation and polishing of the samples for micro analysis. Leading off the micro room is a very efficient dark-room set out to give results in the quickest time with the least trouble. A special laboratory also is fitted up for dealing with work in which acids, etc., are not required. Gas, mine, air and water analyses are carried out. Apparatus for mechanical and physical tests on sands, cements, concrete, cokes, etc., is installed in this room. Road dusts and stone dusts from the collieries also are examined here. In addition to the routine tests experimental and research work are carried out in this laboratory.

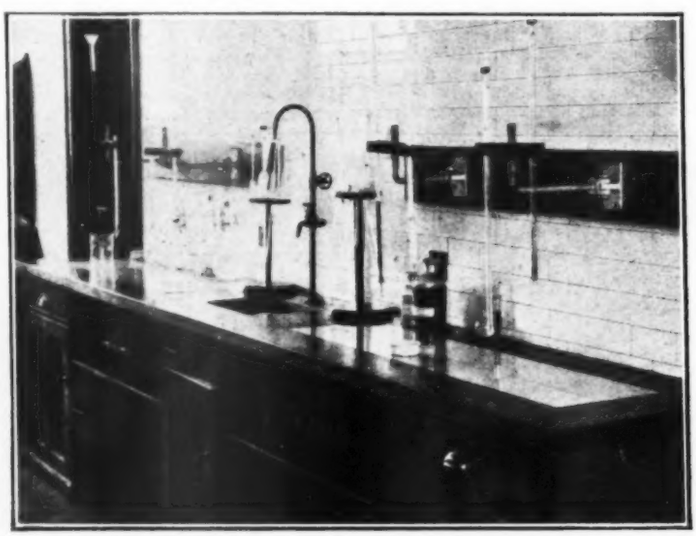


Fig. 5.—This Titration Bench is Glass Covered and Illuminated by Lamps Situated Beneath.

Auxiliary Laboratories.

The remaining rooms comprise the assistants' room, where notes are written up and work tabulated. The chief chemist's office, store room and cloak room. Outside, and away from the main building, is a store for acids and dangerous chemicals, and also a cycle house. It may be mentioned that in addition to this laboratory, there is a routine laboratory at the Spun plant, a laboratory at the Riddings Works and a large laboratory at the Holwell Works. This latter deals with the furnaces and foundry work at Holwell and all the work at the ironstone mines. Altogether a staff of thirty chemists, routine testers and samplers are employed in testing the raw materials and products from the ironworks, collieries, foundries, ironstone mines, quarries, etc. Systematic analyses are made of the ironstone at the quarry face, and truck consignments delivered at the works are also tested. Every cast of pig-iron from the furnaces is analysed, and hourly tests of the cupola metal at the foundries are carried out.

A close watch is kept on the products from the washeries at the collieries. Samples of the various grades of washed slack are taken every two hours, and these samples are mixed and analysed at stated periods. Chemical and physical tests are made on the cements, sands and aggregates, also wire reinforcements used in the "Hume" concrete pipe department. All supplies of tar used for road materials are tested, and if not up to standard specification rejected. Furnace and foundry cokes are tested not only for chemical efficiency but also for mechanical efficiency. Routine tests are carried out daily on the mixture used for coating the pipes, the correct consistency and temperature of the coating material being carefully controlled. The engineering side of the works is also catered for, the laboratory dealing with water analysis, boiler corrosion, flue-gas analyses and temperatures, etc.

From the foregoing it is evident that the Stanton Ironworks Co. have a very real appreciation of the value of a scientific control of productive and manufacturing processes, and they deserve to be congratulated upon the high degree of efficiency they have attained in the organisation of such control throughout their various works, collieries, mines and quarries.

Electric Furnace Company Re-organises.

On account of the increase in their electric furnace business, the Electric Furnace Company, Limited, of 17, Victoria Street, London, S.W.1, have found it necessary to increase the capital, and convert it into a public company. In order to do this, the simplest method is to liquidate the existing company and immediately form a new one with the same name. There will be an interval of a few days between the liquidation of the old company and the formation of the new one, and it will be necessary, in order to comply with legal formalities, to insert a notice in the daily press referring to the liquidation. All the assets and liabilities of the old company are taken over by the new one, and there will be no change either in the direction or policy of the company.

The London, Midland and Scottish Railway have joined the B.C.I.R.A. Mr. R. W. Reid, Vice-President, is the official representative.

The Moulding of Bath Tubs by the Jar Ramming Method.

When making moulds for quite thin-walled castings, such as baths, washing-pots, sinks, and so forth, special attention must be given to ensure uniform ramming of the sand. The mould must consist in all its parts of a sand-layer uniformly rammed, if even and faultless castings are to be obtained. The method of the sand compression also has a great influence on the weight of the castings, because a mould which is not solid will yield heavier castings than a solidly-rammed one. Moreover, any surplus of weight is not paid for by the customer; on the contrary, it is objectionable, because it is not possible to compete successfully with heavy baths in the international trade, as the higher freights and duties involve higher prices.

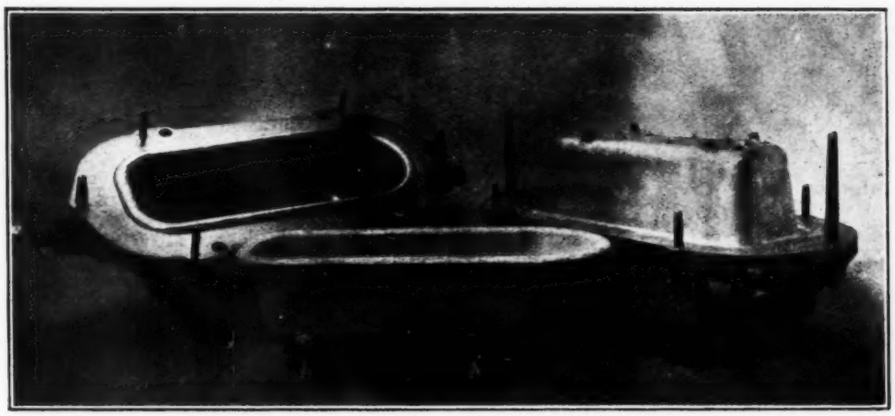


Fig. 1.—The Patterns and the Finished Casting.

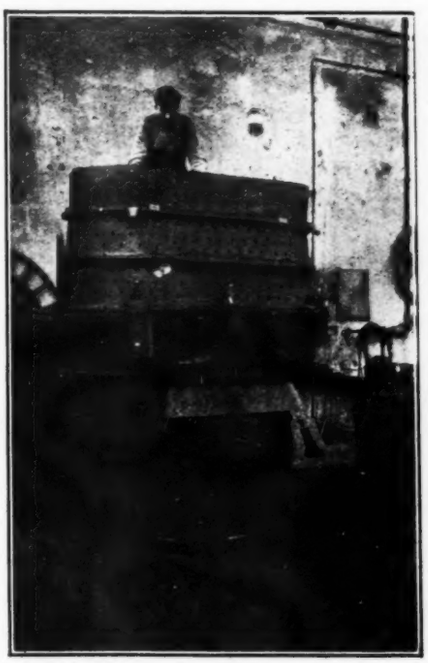


Fig. 2.—Jolting the Top Part.

Fig. 3.—Stripping the Pattern by Overhead Crane.

Therefore only skilled workmen can be employed when moulding baths by hand, because the smallest inattention when ramming will cause faulty places on the castings. A blow from the rammer too near to the pattern is sufficient to spoil a bath, even if sand of the best quality associated with thinly liquid iron are available.

There are various moulding processes for moulding baths by hand. The simplest method is the moulding of baths from a sheet metal pattern which corresponds exactly to the bath, with an allowance for contraction. The pattern serves to mould core and cope, and is treated as every other pattern in loose pattern moulding. The moulding boxes used in this case consist of two or three parts, varying with local conditions. The moulds are rammed by hand, then the top box is lifted off by means of a crane, after which the pattern is removed from the mould by hand and the moulding boxes reassembled by means of the crane. Working with the above plant and with two men the daily output will be generally from about two to three baths.

An improvement over this system of hand moulding consists in the replacement of a simple pattern for the top and bottom boxes by a so-called "bloc-pattern," which is made up of two pattern plates, one for the top and one for the bottom flask. The pattern plate for the bottom half, *i.e.*, the core, is pivotted for turning over the pattern together with the rammed box and then drawing the pattern plate upwards. The pattern plate for the cope part is provided with a device for lifting the mould mechanically just clear of the pattern after the ramming up of the box, before finally removing it with the crane to avoid disturbing the sand, as would be the case when lifting it off too quickly by the crane. Fig. 1 shows the complete plant. With this method of working one also depends on the ability and experience of the moulder, because the sand is consolidated by hand, and inattention or inexperience when ramming will cause defective places on the casting. The daily output of this plant working with four men will be from about eight to ten baths.

The great risk of failures as well as the small output when moulding by hand has been the reason for searching for a method to produce the baths by moulding machines. For instance, it has been tried to mould the baths by hydraulic moulding machines. The boxes are, however, too deep to allow the sand to be properly consolidated without preliminary ramming. Therefore, hand ramming has always been preferred, and the press only used to squeeze the upper layer of sand. An innovation was brought about when the "Badische Maschinenfabrik" of Durlach succeeded in modifying their shockless jolt ramming machine for making baths. It has been definitely shown that the risk of failures is considerably reduced when moulding the baths by this means, because all hand ramming has been superseded and the sand is squeezed independently of the ability and carefulness of the moulder. The moulding of baths on the shockless jolt ramming machines demands the utilisation of separate patterns for the top and bottom flask; naturally machines are necessary, of which one carries the pattern plate for the core part and the other the pattern plate for the cope part. The pattern plate for the core part is moulded on a turn-over table in order to be able to turn after the ramming of the mould. The cope part, however, is directly lifted off without turning over, an operation usually effected by the crane. However, it is advantageous to use for the purpose the stripping device of the machine, the crane thus

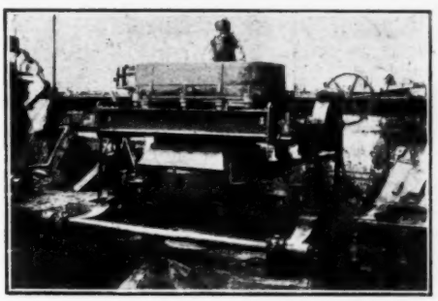


Fig. 4.—Jolting the Core.

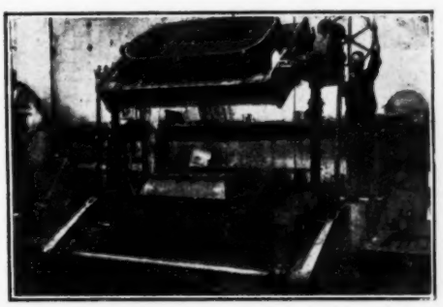


Fig. 5.—Turning Over the Core Part.

being available for other essential duties. When working with two shockless jolt machines, which require four men all told, about eight to ten baths can be moulded in one hour. In such a case, of course, the available resources (travelling crane, sand hopper, number of labourers, and so forth) must play a decisive part.

The filling in of the moulding flasks with sand should, if possible, be done automatically by means of a hopper. The output can be augmented still further if the return of the sand is carried out automatically. The two shockless jolt machines as well as the sand hopper must be laid out according to the local conditions, and whether the available crane power is at one end or on the longitudinal wall of the shop. The finished boxes are placed before the machines and distributed through the whole foundry. Several places

Fig. 6.—Placing the Box on the Trolley.

in the shop must be provided with grates to discharge the finished boxes on to them, and below these grates under the ground there should be a sand conveying plant for taking the used sand back to the sand preparing plant.

Special attention must be paid that the jolt machines are working with short and quick jars, *i.e.*, that they possess a rolling jar, because experience has shown that deep and slow jars are less advantageous for manufacturing baths. Furthermore, the machines must not transfer any appreciable shock to the foundation or to the vicinity of the machines so as to prevent near-by moulds getting damaged by the vibration of the

Fig. 7.—The Core Part Freed from the Machine ready for Removal on the Trolley.

floor. Figs. 2 to 5 show a bath-moulding plant built by the "Badische Maschinenfabrik" under test at Durlach. The machines are placed so low in the foundry that the labourer may operate from floor level.

Fig. 2 shows the simple jolter with the pattern plate put on for the top flask during jolting. In Fig. 3 the top flask is shown lifted off by the crane, whilst in Fig. 4 the bottom boxes, *i.e.*, the core parts, are jolted, and Fig. 5 shows the bottom flask being carried on the turn-over table, the moulder being shown in the act of turning over the table. As soon as the table is turned through 180 deg. and the moulding box hangs downwards, a trolley is pushed in, so that it can take the box. After undoing the catches between the box and pattern device, the pattern is lifted off and the core pulled forward under the pattern plate on to a second trolley for removal.

Critical Points and the Martensitic Quench in Ni and Ni-Cr Cast Iron.

Some interesting and important researches were recently detailed by Messrs. Guillet, Galibourg and Ballay to a meeting of the French Académie des Sciences on the above subject. The following is a statement of the main features of this work.

The rapid cooling of cast iron from the liquid state, which is conducive to the production of the labile state—ferrite and cementite—is usually termed "quenching." Cast irons are equally liable to assume a martensitic state, similarly to steels, if heated to a point above the transformation point and rapidly cooled. The two types of quenching can be called primary quenching and secondary quenching (or martensitic). Moreover, they can assume either state in the course of the initial cooling in the mould.

This communication deals with martensitic quenching of cast irons, especially those containing either nickel or nickel and chromium.

Tests were carried out on a range of irons containing 3.2 to 3.4 per cent. of carbon and 0.90 per cent. of phosphorus, with varying amounts of silicon, manganese, nickel and chromium. The irons worked upon were crucible melted, heated and teemed under definitely identical conditions. The critical points were determined by the differential thermal method, using the double Saladin-Le Chatelier galvanometer and employing prismatic samples, 20 × 15 × 40 mm., taken from similar places in the casting.

Two rates of cooling were used:—

(1) *Slow cooling in the furnace*, average speed being (*v*) from 950 to 450 deg. C., 8 to 10 deg. per min.

(2) *Rapid cooling in the furnace by air blast.* Average speed (V) from 950 to 450 deg. C., 250 deg. per min. The samples were heated to 940 deg., this temperature being reached in 30 to 35 min.

The position of the critical points are given in Table I as well as the differences in hardness (Brinell) of the samples before being submitted to the treatment set out at the top of the column and that obtained from an examination in the "as cast" condition. A negative value corresponds to a softening effect as the result of a heat-treatment. These hardness tests were carried out under a pressure of 500 kilos. with a 5-mm. ball on prismatic samples 8 × 10 × 18 mm. The temperature of 950 deg. C. was maintained before the air-blast quenching. The results, together with numerous hardness tests carried out on large samples, lead to the following conclusions:—

(1) Silicon lifts the transformation temperature and increases the critical quenching speed. It consequently lowers the tendency of the quench to be martensitic. Moreover, it reduces the same tendency to primary quenching, consequent upon the precipitation of the carbon as graphite.

(2) Between 0.20 and 0.65 per cent. manganese slightly lowers the temperature of transformation. It so acts on the critical rate of cooling as regards quenching that it distinctly lowers it. It apparently influences quite appreciably the hardness after the secondary quenching. Within the same limits of contents, manganese has, conversely, only an insignificant action on the primary quenching.

(3) Nickel lowers the temperature of transformation and the critical quenching cooling rate. It permits of the lowering of the change point to below 350 deg. C. It thus operates very favourably on the secondary quenching because, by aiding the precipitation of the graphite, it lessens the tendency to primary quenching.

(4) Chromium, when added to a nickeliferous cast iron, lowers the quenching critical rate of cooling, and thus has, as in steels, a strong influence on the secondary quenching. Logically, it increases the penetration of the martensitic quenching.

(5) These tests clearly indicate the potentialities for the industrial utilisation of nickeliferous and nickel-chrome cast iron, which should be very resistant to wear, and of two kinds:—

(*a*) Easily machinable irons as cast, and yet susceptible to further softening by heating to about 800 deg. C. and cooling in still air or air blast according to the mass of the casting. Sample No. 19 in Table I gives, for instance, a Brinell hardness number as cast of 245, taken with a 10-mm. ball at 3,000 kilos. pressure, but after quenching in air, from 925 deg. C. it increased to 395.

(*b*) Cast irons resembling self-hardening steels—that is, hard "as cast"—but being easily machinable of a short normalising carried out at 650 deg. C. After machining, these irons, which are susceptible to chill, can be easily softened by heating to about 900 deg. C. and cooling in air.

Table I.

Sample No.	Chemical composition.				Temperature of transformation (1).			Increase in hardness in relation to the as cast condition.		
						Cooling		Heated to 500° 45 min. after Casting	Quenched at 925° in still air.	Quenched at 925 in air blast.
	Mn.	Si.	Ni.	Cr.	Heating.	Speed. *v.*	Speed. V.			
1.....	0.24	1.10	0.07	0	795	760	735		+ 2	+ 23
2.....	0.24	1.17	1.02	0	780	740	715		+ 51	+ 54
3.....	0.24	2.11	0	0	820	780	720		− 20	− 16
4.....	0.23	2.06	1.0	0					0	+ 5
5.....	0.24	2.08	1.96	0	790	735	670		− 8	+ 2
6.....	0.21	0.74	4.02	0	720	650	<350(2)	− 33	+ 58	+ 58
7.....	0.22	0.96	5.40	0.14	700	610	<350(2)	− 100	− 21	− 30
8.....	0.61	1.08	0	0	780	730	715	0	+ 30	+ 44
9.....	0.63	1.14	1.09	0	770	710	690	0	+ 56	+ 115
10(3)....	0.59	1.27	2.06	0	760	680	<350(2)	− 12	+ 150	+ 192
11.....	0.57	1.61	0	0	810	760	735		+ 21	+ 32
12.....	0.57	1.61	0.99	0					+ 21	+ 61
13.....	0.57	1.70	1.98	0	780	710	645 et <350(2)		+ 47	+ 133
14.....	0.59	2.08	0	0	825	770	730	0	+ 8	+ 10
15.....	0.61	2.07	1.03	0					+ 18	+ 21
16.....	0.62	2.04	2.06	0	795	725	660	0	+ 79	+ 103
17.....	0.61	1.17	0.62	0.21					+ 33	+ 21
18.....	0.63	1.08	1.07	0.46					+ 30	+ 35
19.....	0.61	1.17	2.01	0. 5	765	690	<350(2)		+ 142	+ 153
20.....	0.61	1.79	2.14	0.70					+ 108	+ 142

(1) Quickest speed of transformation.
(2) Below 350° C the transformation temperature is not very clearly shown by the thermal method.
(3) The T.C. content of this iron is only 2.58 per cent.

The Morgan Crucible Company, Limited, and Keith, Blackman & Company, Limited, have jointly presented the B.C.I.R.A. with a complete melting unit.

General Characteristics of Alloy Steel Castings.*

By J. W. Frank (Chicago, Illinois).

Alloy steel castings are the answer to the demands of the engineer and the manufacturer for steels of improved quality and strength. By the proper application of alloying elements to steel one is able to obtain increased physical properties, such as tensile strength, elastic limit, reduction of area, resistance to impact, resistance to abrasion and resistance to oxidation, that could not be obtained from the best of carbon steel castings. The great strength of alloy steels is being utilised for reducing the size and weight of integral parts, thereby eliminating much of the bulk and weight of the final assemblies, with the added advantage of much uniformity.

Each of the alloy steels has its own definite characteristics. Due to the increased service these steels are able to demand a better price than is asked for ordinary steel castings. By their use, machinery that has multiplied its work power to many times its limit previously set, has been developed.

Three Classes of Alloy Steels.

The characteristics of alloy steels are many and varied. Nevertheless, there are three distinct classes, and their lines of demarcation are clearly marked. First are the steels of high physical properties, such as tensile strength, ductility, resistance to impact, abrasion, distortion and fatigue. The second classification deals with steels with extraordinary properties, such as resistance to corrosion and magnetic permeability.

The third classification deals with the heat-resisting alloys. While these alloys are not, in the sense of the word, alloy steels, their growing application in the make-up of heat treating appliances grants them a place and consideration in this article.

Manganese Steel.

The first of the alloy steels, both in conception and in application, were the manganese steels. Those of low alloy content, from 1 to 1½ per cent. manganese, have not been classified as alloy steels until recently. In the days when the Bessemer process was in general use certain foundrymen, at first by accident, and later by design, permitted the manganese content to rise to this figure, with excellent results. These castings were considered as nothing more than a good grade of converter steel. Of late this steel has been heralded as a new alloy steel, and enormous quantities of it have been sold under many and various trade names. Manganese steel of this analysis, when properly heat treated, has excellent tensile strength and ductility, with very good resistance to abrasion. It has been extensively cast into caterpillar shoes, truck wheels, and, in fact, anything that requires higher physical properties at a minimum of expense. The low cost of this alloy steel is its chief asset, and it can in no way compare with others such as nickel-chrome steel.

Manganese steel of 12 to 14 per cent. content is known universally and has its application clearly defined. It stands alone in respect to hardness and resistance to impact wear. Due to its extreme hardness it cannot be machined, and must be ground into shape. Where machining cannot be eliminated, soft steel inserts must be used, being either pressed or cast into the larger castings. Manganese steel also undergoes a plastic flow or deformation, therefore its use is not recommended where wear is due to abrasion. Castings for ball mills, pulverising machinery and rock crusher jaws illustrate the uses of this high manganese steel.

Alloy steels containing nickel or molybdenum, with manganese somewhat higher than normal, deserve to have a wider acquaintance among manufacturers of steel castings. Manganese has been called the Cinderella of the alloying elements, receiving no credit, and often bearing the brunt of the work.

Nickel-manganese steel usually contains nickel in the neighbourhood of 1 per cent., with 1 to 1½ per cent. manganese. The usual carbon range is 0.30 to 0.40. The use of the nickel obviously adds to its cost, but the increase in ductility and toughness amply justify it. This metal also has a higher Brinell hardness than the straight manganese steel of low content under similar heat treatments. It is cast into substantially the same class of work as the 1 to 1½ per cent. manganese steel.

In the manganese-molybdenum steels the manganese is kept within the same limits, with molybdenum 0.20 to 0.40. The results, as a whole, are the same as with nickel-manganese steel, except that the elastic ratio is raised somewhat.

Nickel Steels.

Nickel steels are the best known and the oldest of all commercial alloy steels. They were developed primarily for use in armour plate and ordnance, but since the war, and the stoppage of naval competition, their peace-time usage has been increased enormously. The nickel range is from ½ to 5 per cent., with carbon 0.10 to 0.60. Its characteristics are a high tensile strength and elastic limit, with very good ductility, fine grained structure, and usually, freedom from blow holes and porosity. These steels are used where extreme toughness is the outstanding requirement. The lower carbon members of this series are invaluable for parts that are to be case hardened. Their use results in a very tough core, with a hard case, which is the ideal condition. Bridge castings, rail clamps and car replacers are a few of the numerous uses to which straight nickel steel can be put.

The alloys of high-nickel content, the magnetic alloys, are hardly of much use to the foundryman, at least, at present. They have abnormal magnetic constants—permeability, permanence and the like. This metal is now made only into bar stock for the electrical industry, but could be cast into motor or dynamo frames, and probably will be some day.

Nickel-Chrome Steels.

The nickel-chrome series constitute a large and comprehensive list. They are very well known, and the most widely used of all the alloy steels now on the market. Nickel and chromium complement each other, and form an ideal combination, having unusually high strength, very good ductility, and a remarkable resistance to fatigue and abrasive wear. The analysis ranges from ½ to 3½ per cent. nickel and from 0.45 to 1.75 chrome, with carbon from 0.10 to 0.60 per cent. The ideal condition is where the ratio of the nickel to the chrome is in the vicinity of 2 to 2½ to 1. As is true with straight nickel steels, the members of this series having low carbon contents, find application in castings that are subsequently case hardened, and, as a general rule, are more or less interchangeable with them, but giving a somewhat heavier and harder case. The medium carbon steels have the widest application and the greatest possibilities. Where abrasive wear is encountered they are supreme. They are used extensively for caterpillar shoes, chain belt, rolling mill rolls, excavating buckets lips and teeth, oil well machinery, hoisting drums, brake drums, special track-work, lightweight car wheels; in fact, for anything where wear is due to abrasion and not to impact. Brinell hardness is valueless as an index to this resistance, but actual service tests have shown, time and time again, that in this respect these steels are superior to others that are much harder. Evidently Brinell hardness has no connection whatever with abrasive resistance. Toughness can be obtained by increasing the alloy content and allowing the carbon to drop to about 0.30. This metal is very useful for high pressure valves and fittings and for railway knuckles.

High Nickel-Chrome Heat-Resisting Steel.

The high nickel-chrome steels, strictly speaking, should not be classified as alloy steels, being really ferrous alloys. The iron is seldom over 60 per cent. and may be as low as 20 per cent. This is really an academic distinction, however, and many steel foundries are making castings of this material at present. The ranges of the alloying elements are extremely wide, nickel varying from 20 to 65 per cent., chrome from 7½ per cent. to as high as 40 per cent. The silicon may be either normal or anything up to 5 per cent.

If carbon steel castings are not solid, are porous or are scabby, their period of usefulness will be shortened, and it is reasonable to suppose that the same would be true of heat-resisting alloys. A good casting of medium alloy content may be equal or even superior to the most expensive composition poorly handled in the foundry.

Recent tests have demonstrated that pots of greatly varying alloy contents, show life entirely disproportionate to the composition. On microscopic examination it developed that some were thoroughly deoxidised while some were not. The lengths of service were definitely in line with the degree of deoxidation. This condition could be due to faulty melting practice, regardless of whether alloy scrap was used or not, or to bad sand conditions. The manufacturer with many years' experience in making good steel castings behind him, obviously has the advantage here. Therefore it would not be an extravagant claim that analysis only be evaluated 25 per cent. for the length of service, good foundry practice being responsible for the other 75 per cent.

The carbon is in some cases as low as 0.20, but in the alloys of high nickel analysis often goes up to over 1.00 per cent. In the alloys of medium content, if the carbon is allowed to be over 0.50 to 0.60 per cent. trouble can be expected from cracking as the castings are very hard and brittle. The function of silicon and small percentages of aluminium in heat-resisting metals has just lately been recognised. Some pots and boxes are even being made in plain 3 per cent. silicon steel, although the author is not familiar with the results obtained.

The heat-resisting steels, if properly made, are tough, somewhat difficult to machine, and show excellent tensile strengths from room temperature to about 955 deg. C. There is a gradual loss in strength, but it is not by any means as rapid as is the case with other metals.

Tensile strength is of no use in design, however, as less of a stress is necessary to cause a rupture, if it is sustained. The outstanding feature of these alloys, as their name would indicate, is their remarkable resistance to oxidation. Failures are seldom due to oxidation, as often they show no trace of scale after almost indefinite length of service. If care is taken in not overloading them and in not heating or cooling them too rapidly their life will be greatly prolonged. The resistance to oxidation of this metal is best illustrated by the fact that it is impossible to cut it with the oxy-acetylene torch which brings them to an intense heat and then exposes them to a stream of pure oxygen. Heat-resisting alloys are cast into annealing pots, carburising boxes, lead pots, branding irons, oil burners, and heat treating furnace parts, such as linings, chain belts, racks, and similar parts for furnaces used in vitreous enamelling. A rather high price is paid for such castings, but they prove very economical when the heat-hours are taken into consideration. In this field especially, intensive advertising is carried on, and without exception, all alloys are marketed under trade names.

Chrome Steels.

Straight chrome steels of low content have been cast but their use is uncommon. Chromium, by itself, gives more hardness than carbon, and at the expense of decreased ductility. The chromium is usually from 0.60 to 1.50 per cent. with carbon usually from 0.15 to over 1.00. These steels, especially those containing the more carbon, are used where rigidity and freedom from distortion are the predominating requirements.

The high chrome steels are the stainless steels and irons. The minimum chromium content is 12 per cent., but some contain as much as 40 per cent. The members of this series that have the lowest carbon are the so-called stainless irons, but they are all made by the same processes, so are really steels. They do not require any heat

* A Paper read before the Philadelphia Meeting of the American Foundrymen's Association. The author is Chief Metallurgist to the Chicago Steel Foundry Company.

treatment to bring out the stainless properties, while the stainless steels do. The carbon is seldom over 0.60 in any event.

Oil refineries have been heavy buyers of castings of this material lately for equipment used in the cracking of the crude petroleum oils, which have a corrosive action at high temperatures due to a high sulphur-content. Castings have also been made for food-handling machinery, both to keep the food products free from contamination and to increase the life of the equipment. As ordinary steel castings have a very limited period of usefulness in the handling of acids and caustic alkalis, chemical industries have been using increasing quantities in the form of agitator arms, kettles, pipe lines, driers and other parts. The irons have the maximum resistance to corrosion, but are only moderately hard. The stainless steels are also said to take and retain a better polish.

Molybdenum Steels.

Nickel and nickel-chrome steels were so enthusiastically received by industry in general that investigators were encouraged to study other elements as potential alloys. The most successful of these are the molybdenum and vanadium steels and combinations with elements mentioned previously.

Straight molybdenum steel is not common in castings at present. The molybdenum is usually 0.20 to 0.40, but may be as high as 0.80 per cent. The main advantage in using this metal is the relative ease in welding them to other parts in fabricating.

Molybdenum in conjunction with chromium produces a steel, the use of which is increasing by leaps and bounds. The uncertainty of results that has been troublesome in the past has been entirely eliminated with improved methods of adding the molybdenum. The outstanding effect of the molybdenum is the unusually high elastic ratio, with high tensile strength and good ductility. The advantage of this steel over chrome-nickel is the ease with which it can be machined. In actual practice it has been shown that, at the same Brinell hardness, a considerable saving can be made in the average time of each machine shop operation. The tempering temperatures of this steel are unusually high, and it is less susceptible to overheating. Molybdenum is almost always kept within 0.20 to 0.40 per cent. and the chromium 0.70 to 1.10 per cent. Carbon is usually 0.20 to 1.00 per cent. for the general run of work. Steel of this analysis is especially tough, and has been used with success in blooming mill rolls. If the carbon is allowed to rise above this figure to almost 2.00 the rolls are extremely hard and rigid, and have excellent resistance to abrasion.

The addition of molybdenum to a nickel-chrome steel results in a metal that should be of particular interest to foundrymen. It retains all of the good qualities of the nickel and the chrome, the ease of machining of the chrome-molybdenum steel, and, in addition, has the peculiar characteristic of hardening almost as hard by air quenching as if a liquid medium were used. It is an ameliorative for diverse castings, the nature of which makes water or even oil quenching precarious. Distortion can be kept at a minimum, internal strains lessened, fire cracks eliminated, and the cost of the heat treatment appreciably lowered. Some of the finish can be pared off the patterns, thus saving additional time and expense in machining. This makes nickel-chrome molybdenum steel the ideal metal for cast die blocks. These are steadily displacing forgings, due to the heavy expense of sinking the die into a solid block. They can also be re-sunk very cheaply, as they can be re-machined without annealing. With low carbon, at or nearly 0.30 per cent. and higher nickel and chrome, a steel of very high ductility and elastic limit is obtained. It is highly recommended for high pressure fittings, for railway knuckles, and wherever great dynamic strength is necessary.

Chrome-Vanadium Steels.

Castings of chrome-vanadium steel have been made for some time, but have never come into general use. Vanadium steel specifications are always "minimum 0.15 per cent., 0.18 per cent. desired," chrome 0.80 to 1.10 per cent. It also has high tensile strength and good ductility, but its characteristic is its resistance to fatigue. Since the steam locomotive has had its power and weight increased many frames and other massive parts have been made in alloy steels. Chrome-vanadium steel has been most common in these castings.

Care in Manufacture of Alloy Steels.

Alloy steel castings, in general, require more care in manufacture than do castings of plain carbon steel. As cast they are hard and brittle, and unless properly annealed, are apt to remain so. In general, the cast structure is harder to break up, and at the same time it is essential that this be done. They require a longer annealing at a higher temperature, as a rule. Care must be taken, if surface welding is necessary that such parts be re-annealed, as otherwise hard spots are sure to be found on machining.

The real benefits of the alloy additions are not brought out unless the castings undergo a heat treatment. A simple air-quench from annealing temperature, followed by tempering at a comparatively high temperature, often accomplishes great improvements as compared with the results obtained by a straight anneal.

Alloy steels cannot be considered a panacea for all the troubles that arise in the use of steel castings. Neither must the user place the blame for isolated poor results, on the contained alloys. The user must use the same discrimination in judging results, that he uses in his judgment of ordinary steel castings, as well as other products. He must not let results of the products of second-rate manufacturers of steel castings blind him to the results that can be obtained with a first-class alloy-steel casting

Alloy steels have come to stay. The steel foundryman must be constantly on the alert to improve quality, and to take advantage of improvements when they arise, so that he will be able to get his share of this large and constantly increasing class of business.

Death of Mr. William Wolfe.

Messrs. Hollingdrake's Managing Director Dead.

We regret to annouce the death, on August 12, of Mr. William Wolfe, the chairman and managing-director of Messrs. Henry Hollingdrake & Sons, Limited, the Stockport ironfounders, which occurred at his home, "Aldworth," Brackley Road, Heaton Chapel. He had been in failing health for three months.

Mr. Wolfe belonged to an old and well-known Stockport family which has a connection with Messrs. Henry Hollingdrake & Sons extending over three generations. His father, the late Mr. Oliver Wolfe, was the firm's foreman for 35 years, and Mr. William Wolfe had been there all his working life—48 years. On the death of his father 29 years ago he was made foreman, and about twelve years ago he was given a seat on the directorate, being made chairman and managing-director after the death of Sir Henry and Mr. Herbert Hollingdrake. His brother, Mr. P. B. Wolfe, was also formerly connected with the firm, and his son is in the firm's employ.

Mr. Wolfe was president of the Manchester and District Ironfounders' Association this year. He was of a retiring disposition, and the demands made upon his time by business affairs precluded his participation in the public life of the town. But he had a long connection with the Stockport Sunday School, and did valuable work there as a trustee, member of the committee, and visitor.

Mr. Wolfe was in his 63rd year. He leaves a widow and one son.

United States Steel Corporation.—The consolidated net earnings of the United States Steel Corporation for the June quarter were $46,932,000, against $46,040,460 a year ago. In the June quarter $2.75 was earned for the common stock, against $2.11 in the previous quarter and $2.79 in the second quarter of 1927. A regular quarterly dividend of $1¾ per share was declared, leaving a final surplus over dividends for the half-year of $9,683,000, against $23,323,000 in the first half of 1927.

Copper *versus* Lead.—The Roofing Problem.

By "Onlooker."

The Dean and Chapter of Peterborough Cathedral have for years been waging an expensive war against that deadly enemy of ancient structures, the death-watch beetle, and now the greedy insects, having presumably grown tired of woodwork, have turned their attention to the lead covering. Definite evidence of their ravages in metal an eighth of an inch thick has been discovered, and there seems no reason to suppose that had the sheeting been twice as heavy the beetles would still have managed to force their way through. The cathedral authorities are faced with a difficult and costly problem, but they will probably find that copper substituted for the lead is the only answer.

Slowly, but surely, copper is making progress in this country as a popular and efficient top covering, and in many ways it may be considered to be the ideal roof. In America it is, of course, well established, and much useful propaganda work has been done by the Copper and Brass Research Association to this end. Typical examples of copper roofing on a big scale are the Mellon National Bank, Pittsburg, and St. Dunstan's Cathedral, Charlottetown, for over twenty tons of metal were employed in each case. The initial outlay would, of course, be heavy, but there is satisfaction in knowing that such a roof is virtually indestructible, and, as far as the writer's knowledge serves, proof against attacks from insect pests. The famous church of Philadelphia boasts a roof 175 years old, and as far as can be ascertained, it is just as good as on the day it was installed.

Lead can, of course, offer many of the advantages claimed by copper, and it may be argued that it costs only a third of what copper does. The market quotations of the two metals are roughly £30 and £90 in sheet form, and the values of the dismantled roofs as scrap bear a similar relationship, but it must be remembered that a square foot of copper 1/16 in. thick, which is the standard weight for roofing sheets, weighs 2.9 pounds, while lead 1/8 in. thick (thinner than this is not suitable for large buildings) weighs 7.4 pounds. Various technical points crop up in regard to the installation, etc., but on the whole copper is as easy to work as lead, and in case of a fire it will not melt so readily. Another big point in its favour is, of course, the greater ease with which it can be handled, and an S joint between the sheets hammered flat gives absolute security against all weathers.

So much for a comparison of the two metals on purely utilitarian lines, but the builder working to a scheme of ornamentation and anxious to impart dignity and character to the erection under his charge will welcome the opportunity of employing copper as a roofing unit. Overlapping copper shingles making watertight provision are nailed in position by copper nails and make a very pleasing exterior as well as a most adequate protection. Spanish tile is also reproduced in copper, but weighs only about one sixth of the same product in clay. For flat roofs over porches and entrances, sheets with a soldered joint are used, while a very stylish but more expensive type is the batten, laid on ribs of copper with bevelled edges.

Lead has not, of course, been used except in plain sheet form for covering large roof areas, and the metal is too soft to stand working up into the tiles or ridges. A hundred tons of lead on the top of a big building requires a very strong roof frame to carry it, and copper offers protection and permanence quite as adequate with much less weight of metal and a corresponding decrease in initial expenditure on the framework. For flashings, downspouts, and gutters, copper comes into competition with zinc and cast iron, and although the first cost is undoubtedly heavy by comparison, the job may be considered next door to a permanency, whereas, as every householder knows, the trouble from leaky gutters and downspouts is almost everlasting.

Manganese Steel.*

By H. P. Evans and A. F. Burtt.

Introduction.

Perhaps the first mention of non-magnetic iron-manganese alloys is by Rinman, who in 1774 observed that the white brittle metal obtained by fusing equal parts of grey pig-iron and manganese oxide was not attracted by a magnet. About 1830 David Mushet prepared alloys containing up to 30 per cent. manganese, using manganese oxide, iron oxide, cast iron, charcoal and a fluxing agent. He noted the non-magnetic nature of the metal but apparently the carbon-content was too high to give the properties later obtained by Hadfield. Considerable investigations of manganese additions were carried out by German producers and more especially the Terre Noire Works in France about 1875. The reports of these investigations tended to show that steels containing much over 1.00 per cent. manganese were brittle. The reports included an alloy of 11 per cent. manganese content, but the carbon content was 2.42 per cent. and the steel was brittle.

Historical.

In the face of these and many other discouraging reports concerning manganese alloys Sir Robert A. Hadfield, Bt., F.R.S., in 1883 finally produced the alloy known throughout the world by his name—Hadfield steel or more commonly called manganese steel. This alloy has the following analysis:—Carbon, 1.00 to 1.45; manganese, 10.00 to 14.50; silicon, 0.30 to 1.00; sulphur, 0.01 to 0.03; and phosphorus, 0.04 to 0.10 per cent.

The ratio of the carbon and manganese contents is maintained at approximately 1 to 10. Hadfield published an exhaustive report in the Journal of the Iron and Steel Institute in 1888. Hadfield first used the converter for the manufacture of manganese steel. He melted low phosphorus, low sulphur pig-iron in a cupola and then blew it dead in a converter. Molten ferro-manganese, melted either in a special cupola or crucible was then added to bring the heat to the proper analysis.

One of the chief difficulties encountered in this process was the inability to use old heads, gates and other manganese scrap without the attendant loss of manganese due to oxidation during melting. Air furnaces were used to a certain extent, but many hundreds of tons of manganese scrap were piled away awaiting the discovery of a method of retaining the manganese content of the scrap. Advantage was taken of the so-called Swedish practice of blowing converter metal, whereby a portion of the heat developed during the blow is obtained from the manganese in the metal, thus utilising the manganese content by using it as a source of heat. Improvement in cupola practice of melting ferro-manganese by the use of a low-blast, low coke-ratio, etc., cut down the loss of manganese in the melting of ferro-manganese. With all the improvements available, however, there was a considerable loss of manganese during melting, and not until after the advent of the electric furnace was it possible to make manganese steel using manganese scrap without a considerable loss in the manganese content.

The manufacture of manganese steel by the open-hearth process was handicapped by the fact that it is impossible to refine a charge containing manganese steel scrap without the loss of most of the manganese due to oxidation. Hence all manganese steel made in the open-hearth has been made by ladle additions of ferro-manganese. While it is possible to make excellent manganese steel by ladle additions of ferro-manganese, and many tons of open-hearth manganese steel have given satisfactory service in industry, the inherent difficulties of this method and the opportunities for obtaining a non-uniform product are perfectly evident.

The first electric furnace melting practice used for manganese steel was similar to that used for carbon steel. A basic bottom was used because the basic manganese slag attacks an acid lining. Soft steel scrap was melted under an oxidising slag, and the slag removed. A second slag was added and the heat finished under reducing conditions exactly as for carbon steel. Finally the required amount of ferro-manganese was added, the bath brought to the proper temperature and tapped. Soon it was found that the ferro-manganese could be added immediately after slagging off, the subsequent practice remaining unchanged. A little later the ferro-manganese was added immediately after the heat was melted and then the heat was finished under a single slag. Later full advantage was taken of the neutral atmosphere of the furnace during the melt-down and the reducing action of the carbide slag permitting the melting of ferro-manganese and manganese scrap from a cold charge and finishing under a single carbide slag.

Basic Electric Melting Practice.

While it is possible in a general way to describe the present-day practice of melting manganese steel in a basic bottom electric furnace, there are specific conditions arising peculiar to manganese steel that necessitate very careful operation and the employment of a very responsible melter well acquainted with the peculiarities of manganese steel. Low-carbon, low-phosphorus steel scrap, manganese-steel scrap and sufficient ferro-manganese to bring the manganese content of the bath when melted almost to the specifications are charged cold into the furnace. The manganese steel scrap may range from none to practically 100 per cent. of the charge. Power is turned on, using high voltage for melting down in order to shorten the time of this operation. Since gases are being given off constantly from the burning of the electrodes there is at all times a pressure of gas out through the door and tap hole. Practically no air enters the furnace and any oxidation results almost entirely from the rust and oxides of the charge. It is due to this fact and to the presence of a carbide slag during the finish of the melt that manganese scrap and ferro-manganese can be added with the initial charge in the electric furnace without the loss of manganese that occurs in the converter and open-hearth furnace. When the charge is melted the bath is stirred and a laboratory test is taken. Ferro-silicon is added, and lime, fluor-spar and coke added to form a slag. The furnace is operated under a lower voltage in order to protect the refractories, and the refining operation begins. Necessary additions as indicated by the laboratory analysis are then made. If it is desired to raise the manganese without raising carbon, silico-manganese or low carbon ferro-manganese are added. The bath is stirred vigorously and proper additions are made to form a carbide slag.

Deoxidation.

Calcium carbide is a very strong deoxidising agent. Doxidation is accomplished as shown by the following reaction:—

$$Ca\,C_2 + 2\,FeO \rightarrow CaO + CO + 2\,Fe$$
$$Ca\,C_2 + 2\,MnO \rightarrow CaO + CO + 2\,Mn$$

Since the CO is formed at the contact of the slag and bath, and not in the body of the metal, it is not absorbed and dissolved by the bath to an appreciable extent. The iron and manganese go back into the bath and the CaO into the slag. The carbide first reduces the easily reducible oxides of the slag. It then attacks the oxides dissolved in the bath. Due to the surging action of the bath and occasional stirring these oxides are removed from the bath and the metal from the oxide returned to the bath and deoxidation is complete.

Desulphurisation.

Calcium carbide is probably the most efficient desulphurising agent known. Desulphurisation is accomplished by the following reaction:—

$$2\,CaO + CaC_2 + 3\left(\frac{MnS}{FeS}\right) \rightarrow 3\,CaS + 2\,CO + 3\left(\frac{Mn}{Fe}\right)$$

Since sulphur is naturally removed by manganese under a basic slag this additional removal brings the sulphur content down to almost a negligible point, and sulphur ceases to be a problem.

Degasification.

The ferro-silicon acts as a degasifying agent as follows:—

$$2\,CO + Si \rightarrow SiO_2 + 2\,C$$

Ferro-silicon additions should be made early enough during the finish of the heat that time is given for the resulting silicon dioxide to separate from the bath.

Pouring Practice.

The teapot ladle seems the most satisfactory type of ladle for manganese steel, though the bottom pouring and lip ladle are used quite often with success. Care must be exercised in controlling the pouring temperature of the metal. If poured too hot excessive shrinkage and a cutting action in the mould most pronounced at the gated end is apt to occur. Large heads, gates and risers permit the pouring of the heavy jobs on the cold side. Light work is poured of hotter metal.

Manganese steel is not adapted for the wide range of analysis used in carbon steel. Different types of castings, however, do require somewhat different analysis. In general, heavy work, especially of irregular section, is poured from metal of less than 1.25 per cent. carbon in order to obviate the liability of cracking during cooling. In some work where hardness is essential even with the sacrifice of some ductility the carbon may be raised to 1.40 per cent.

The shrinkage of manganese steel is considerably greater than that of carbon steel, so all patterns must be made accordingly. The shrinkage of carbon steel is not over $\frac{1}{4}$ in. per foot, while that of manganese steel is approximately 5/16 in. per foot. Because of this fact, and other factors peculiar to manganese steel, many unsatisfactory and weakened castings are turned out of foundries not thoroughly familiar with manganese steel through daily contact with it on the floor.

By the proper use of chills in the mould at the junction of two different thicknesses of metal, rates of cooling of the two sections can be controlled and cracking eliminated. After the castings are cooled sufficiently they are shaken out.

All railway castings are relieved as soon as they are set. The gates and heads are dug out, bars bent and copes raised so that the castings may cool lying free in the drag.

Particularly difficult castings subject to undue stresses while cooling are shaken out hot and immediately placed in the annealing furnace and annealed without being allowed to become cool. Heads and gates which are broken off are removed before heat treating, because they are too tough to be broken after the heat-treatment. The larger heads and gates are burned off.

Heat-Treatment.

Heavy castings annealed in a car type furnace are brought to a temperature of 870 deg. C. and allowed to soak at this lower temperature in order to obviate the excessive oxidation that would occur by soaking at the quenching temperature. They are then brought to a temperature of from 1,010 to 1,050 deg. C. and quenched in water. Smaller castings treated in a suitable furnace are quenched in water from the same temperature. After a sand blast the castings are ground to the proper finish and straightened, if necessary. The grinding department is a very important part of a manganese steel foundry. Since the castings are too tough to be machined commercially, all finishing is done by grinding, and elaborate grinding equipment is necessary to obtain the finish and close tolerances demanded by the customer. Soft steel inserts are cast in parts where machining or drilling is necessary.

* A Paper read before the Philadelphia Meeting of the American Foundrymen's Association. The authors are, respectively, Metallurgist and Assistant Foundry Superintendent of the Pettibone Mulliken Company, Chicago, Ill.

XUM

Properties of Manganese Steel.

Manganese steel is comparatively soft, registering a Brinell number of 150 to 200, and yet possesses a peculiar toughness that withstands the action of the best tool steel. It possesses the elasticity and ductility of soft steel and at the same time possesses the extremely high tensile strength of 44 tons per square in., which enables it to withstand the severe shocks under which ordinary steels fail completely.

The following are the physical properties of properly heat-treated cast manganese steel:—

Tensile strength	35 to 62 tons per sq. in.
Elastic limit	13 to 20 tons per sq. in.
Elongation	25 to 35 per cent.
Reduction of area	20 to 35 per cent.
Brinell hardness	170 to 200
Scleroscope hardness	40 to 50

Because of a peculiar slipping along its planes of cleavage when under heavy stress manganese steel does not have a definite yield point, and this figure cannot be obtained by the drop of the beam. For the same reason the elastic limit is hard to obtain. A ½ in. square cast-bar after heat-treatment should bend 180 deg. around a pin of its own diameter.

The shearing strength is very high—much higher than one would expect from the elastic limit. This is caused by the hardening during cold deformation mentioned later.

Structure of Manganese Steel.

Manganese steel as cast has an austenitic structure with carbides segregated along the grain boundaries of the austenite grains and scattered throughout the grain itself.

When properly annealed and quenched these carbides are dissolved into the austenite at the high temperature and, due to the obstructive action of the high manganese content, are retained in solution by the drastic quench in water. If improperly heated or quenched, portions of these carbides may either remain undissolved because of insufficient annealing or come out of solution again because of slow cooling during the quench.

At times the stresses set up in the metal while cooling may develop slip planes in the austenite grains, and show as hair lines running along the cleavage planes of the separate austenite grains.

Peculiar Changes Caused by Tempering and Cold Work.

When manganese steel is given a drawback after water quenching it loses its toughness and changes to a hard brittle martensitic or cementitic structure. When it is given a sufficient drawback to reach a Brinell number of 450 it will possess a specific magnetism approximately 40 per cent. of that of Swedish iron rated at 100 per cent. The lancelike structure seen when viewed under the microscope, and the high specific magnetism identify the structure definitely as martensitic at least to a considerable degree.

When subjected to severe stresses, such as compression, tension, or repeated blows, manganese steel tends to slip along its planes of cleavage and develops a hard structure which in extreme cases reaches a Brinell hardness of 500. When the Brinell hardness is raised to 450 by cold work the resulting specific magnetism is less than 5 per cent. of that of Swedish iron, and the resulting structure when viewed under the microscope differs from the original austenitic structure only in that it shows very definite slip planes. The identity of this latter structure is a much mooted question among metallographic authorities.

The superior wear resisting properties of manganese steel are due to a considerable extent to the hardening action that takes place when the casting surface is subjected to shock. As the surface is slowly worn away the newly exposed surface has been hardened by the previous shock, and thus there is throughout the life of the wearing part a tough body of metal with an extremely wear resistant surface at all times exposed to the abrasive material. At times a casting subjected to extremely heavy shock and seemingly the worst possible type of service may wear even better, due to this extreme increase in hardness, than a casting receiving a purely abrasive wear and no shock.

Uses of Manganese Steel.

Manganese steel castings stand in a class by themselves for use in many wear resisting and shock absorbing parts. A few of the specific uses are as follows:—

Railroad Work.—Frogs, switches, crossings, guard rails, etc.

Crusher Parts.—Liner plates for ball and rod mills, mantles for gyratory crushers, hammers for hammer mills, jaw plates, and roll shells.

Other Miscellaneous Parts.—Dippers and dipper teeth, tractor shoes, chain, sand suckers and pumps, conveyors, shutes, gears, sheaves, etc.

The Relation Between Silicon Contents and Thickness of Iron Castings.

By Our Metallurgical Correspondent.

It is not surprising, in view of the complexity of cast-iron and the number of conditions which have an appreciable influence on its properties, that the vigorous examination of the various formulæ and graphical expressions which have been put forward from time to time, relating various properties of cast iron one to the other, reveal defects. In spite of this the concise expression of certain relationships is often of distinct value in industrial use. From this point of view it is possible to justify the use of certain of the formulæ or graphical expressions, always providing that their limitations are clearly understood. It is probable that the most justifiable expressions are those which attempt to relate the silicon content and the thickness of castings. Long experience has shown the desirability of relating the silicon content to the thickness of the castings in actual practice, and in spite of all the changes

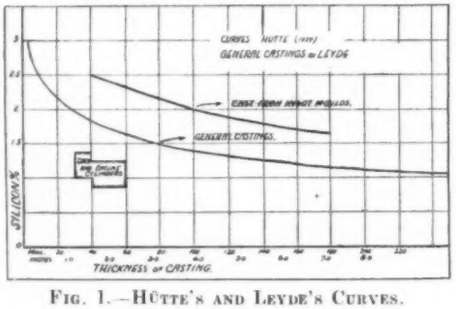


Fig. 1.—Hütte's and Leyde's Curves.

and fuller understanding of cast iron to-day the relation of these two factors still remains one of the most prominent features of foundry metallurgical practice.

Generally speaking, British writers and British text-books have avoided expressing the relationship between silicon content and casting thickness by anything of so intimate a nature as a formulæ or graphical expression, and they have contented themselves by the simple tabulation of preferred ranges of silicon content corresponding to certain ranges of thickness. Recommendations in this form are now familiar to most foundrymen. Continental workers have been somewhat bolder in this matter, and most of the formulæ which have been put forward have found their origin in Continental, principally German, foundries and laboratories. The now familiar expression $Sc = \frac{C}{4.26 - \frac{Si}{3.6}}$ where Sc is a kind of constant, C is the total carbon, and Si the total silicon expressed in percentages is of German origin. This formula is clumsy in form and in operation, and it is equally as simple to remember the total carbon and silicon contents in a simple and direct fashion as it is to remember the arbitrary ranges of constants, which are set out in full below:—

Sc = 0.76 — 0.85	for internal comb. eng. cylinder.
Sc = 0.8 — 0.9	,, locomotive cylinder.
Sc = 0.9 — 1.0	,, general castings.
Sc = 0.9 — 1.0	,, ingot moulds.
Sc = 0.71 — 0.83	,, rolls.
Sc = 0.75 — 0.88	,, hard cast iron.
Sc = 0.9 — 1.0	,, cast iron pipes.
Sc = 0.87	,, electrical castings.
Sc = 0.85	,, acid castings.

A most interesting curve or graphical relationship between the silicon content and the casting reproduced from Hütte, together with a special thickness is that given by Leyde.* This curve is curve for ingot moulds in Fig. 1. The shape of this curve generally commends itself, but in the light of more modern practice the silicon contents are generally at a high cost. It is of considerable

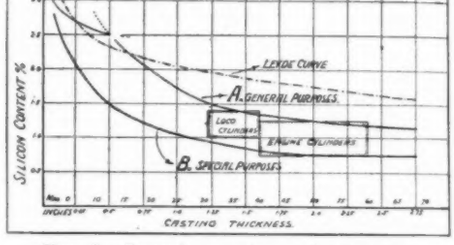


Fig. 2.—Leyde's and Author's Curves.

importance in view of modern practice to note the rectangular areas below the curves representing the recommended silicon contents for use in the case of locomotive and engine cylinders. These are closely in accordance with what is considered by many to be strictly modern policy.

It is of considerable value to compare these curves with a series of curves prepared by the author some years ago, and illustrated in Fig. 2. The general casting curve, after Leyde is plotted in the diagram in dotted lines and the two full line curves A and B represent the relation between silicon contents and casting thickness for general purposes and special purposes respectively. These two curves practically enclose the shaded area corresponding to the recommendations for locomotive and engine cylinders shown in Fig. 1. On account of the more open scale of Fig. 2 these areas are more elongated. The lower curve for special purposes is only recommended for those castings which are made under carefully controlled conditions. In using this curve special attention must of necessity be paid to the manganese and sulphur contents, casting temperature and moulds to obtain uniformly successful results.

* "Stahl und Eisen," 1904, Vol. II, p. 879.

Personal.

Mr. G. Murray has resigned his position as chemist to the B.C.I.R.A., and has been succeeded by Mr. C. Rowley.

Mr. Sidney Owen, senior lecturer at West Hartlepool Technical College, has been appointed head of the engineering instruction for North Devon.

Dr. W. H. Hatfield (director of the Brown-Firth Research Laboratories, Sheffield) is to deliver the Campbell memorial lecture during the annual convention of the American Society for Steel Treating to be held in Philadelphia the week of October 8 concurrently with the National Metal Exposition. The subject of the Paper will be "The Application of Science to the Steel Industry."

Wills.

Mills, William, of Llanidloes, senior partner of John Mills & Company, engineers	£14,990
Roberts, David, J.P., chairman of James Coultas, Limited, Perseverance Ironworks, Grantham, and a director of Ruston & Hornsby, Limited, Lincoln	£42,780

Notes on the Routine Analysis of Cast Irons and Iron Foundry Raw Materials—No. 1.

By Arthur Smith, M.A.

Sampling.

Although much has been done in recent years to introduce more or less recognised standard routine methods of analysis in the steel industry, the same cannot be said of many laboratories dealing mainly with pig-irons, cast irons, and iron foundry materials in general. Dealing in the first instance with cast irons, it should be noted that many methods which are ideal for carbon and even alloy steels are not suitable without considerable modification for application to cast-iron samples. Unfortunately, in this country unification and standardisation of analysis has not yet been achieved in the steel trade, far less in the realms of cast iron, and the need for the adoption of really reliable standard methods laid down by some recognised and competent central body becomes urgent, especially as the production of steel-mix, high-duty, as well as alloy cast irons increases.

It has been left largely to private enterprise such as that of Messrs. Ridsdale & Company, of Middlesbrough, to provide such standard materials as are available, and admirable as the work of the Ridsdales has been, cast irons have of necessity had to occupy second place. Certain standards certified by the National Physical Laboratory are also available, but as far as cast irons are concerned, the provision of standard materials the composition of which has been ascertained by standard methods leaves much to be achieved.

In the writer's opinion there is great commercial need for the establishment of universally, or at least nationally, approved standard materials for the checking of analysts' work on cast-iron samples. The estimation of the composition of any substance by analytical methods must of necessity be relative and can never be absolute, but the degree of relativity, or rather the proximity to the absolute state, will depend on the methods adopted and the degree of accuracy aimed at.

Much routine analytical work has to be carried out by junior assistants whose training is far from complete, and it is essential that such work may be rapidly checked where desirable, but it is impossible to do so unless definitely standard methods of procedure are adopted.

Public Laboratories and Large Errors.

This becomes increasingly evident when samples of cast iron are sent to different analysts, and widely different figures are returned. This diversity of analysis is sometimes alarming, as the writer has known of cases where the phosphorus content in a sample of cast fron proved conclusively to be between 0.17 and 0.18 per cent. was repeatedly returned by a public laboratory (*i.e.*, a metallurgical laboratory not connected with a foundry) as 0.32 to 0.35 per cent., and in another case silicon 1.01 to 1.03 per cent. to be repeatedly returned as 0.75 to 0.78 per cent., showing that so-called agreement of check results by one method or one analyst may be in hopeless disagreement with those by another method or analyst. In one extreme case of phosphorus in cast iron being in the neighbourhood of 0.24 to 0.25 per cent., a laboratory returned a certified figure of 0.73 per cent. when a portion of the same drillings was sent, even although they more or less agreed on the other constituents. The above are exceptional, but disagreements of 0.1 to 0.32 silicon are often met with, and for certain classes of work are serious.

With the advent of much low-silicon, low-phosphorus, high-manganese, and probably high-sulphur cast iron, the need for rapid yet sufficiently accurate commercial analysis becomes more urgent still, and the necessity is being accentuated by the introduction of nickel and nickel-chromium cast irons, where slight alterations of composition will result in considerable differences in the physical properties of the material.

In the present article the writer, without wishing in any way to be dogmatic, gives his views on the various recognised methods available for the constituents usually estimated in cast irons, and indicates the method he prefers to adopt as his standard for routine commercial work in the hands of junior assistants, where not only rapidity of working combined with the necessary accuracy, but also reliability, is aimed at. By reliability is meant the power to reproduce the same results (within predetermined relative limits of accuracy) from any number of portions of the same sample of drillings. The limits of accuracy and experimental error will be discussed when dealing with each individual constituent, and naturally the limits of error laid down for cast irons must be wider than is the case with steels, because of the much greater lack of homogeneity in the former, and also the limits assigned to commercial routine work must of necessity be more lax than those for definitely accurate work for research or similar purposes.

Before dealing with the individual elements which are present in cast irons, either as elements (carbon) or as compounds, certain broad principles must first be dealt with, and the first and most important is the question of sampling. As some cast irons, especially low-grade, high-phosphorus, high-carbon irons are very heterogeneous in structure, sampling presents many difficulties. First of

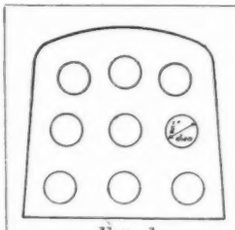


Fig. 1.

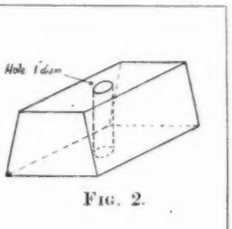


Fig. 2.

all, when dealing with pig-irons or unmachined castings, it is essential that all sand, plumbago or other non-metallic materials be removed from the skin of the piece or pieces from which the sample is to be taken. Where sand-blast plant is available, this is most conveniently accomplished by that method. In sampling pig-irons there is much diversity of opinion as to the best method of sampling. The author prefers to drill six holes ½-in. diam. of equal depth, that is to say, the actual depth does not matter so long as all the holes are of equal depth at regular intervals from a section of pig-iron taken approximately from the centre of a pig or sow as indicated in the diagram Fig. 1.

Some authorities have suggested the use of a template for this purpose, and the idea is sound provided the templates are adapted to synchronise with the different surface areas of individual pigs. Another and simpler method which has much to recommend it is the drilling of a ¾-in. or 1-in. diam. hole right through the middle of the pig from top to bottom, as Fig. 2. In each case, provided the skin has been freed from non-metallic impurities, *all* the sample must be collected. A drilling machine can be suitably adapted for the purpose, and, of course, all drilling should be done dry to avoid subsequent cleaning and drying. Where the use of a lubricant has to be resorted to, or where drillings and turnings from a cast-iron casting machined in the presence of a lubricant have to be used, the drillings must be very carefully washed with a suitable solvent such as ether, benzene, or carbon tetrachloride, and subsequently dried at a temperature sufficiently low to exclude any possibility of oxidation. Great care must be taken in collecting the drillings that they do not become contaminated with any solid carbonaceous or other foreign substances. The same remarks apply to the sampling of other forms of cast irons or ferro-alloys, and in the case of castings due regard must be given to the section of the casting from which the sample is taken if it is necessary to estimate the amount of combined carbon present. Similarly, when estimating elements which form compounds which are liable to segregate, it must be decided first whether a general or local sample or both is necessary in order to obtain the information required. For instance, if an individual piece of pig-iron is being analysed for sulphur, a general sample of that piece will be necessary, but if, say, a top-run hydraulic cylinder casting, say 12 ft. long and 2 in. general wall thickness, complete with feeding head, is being studied, then a sample taken from the top 3 ins. or so would probably contain much more sulphur than a sample taken from the extreme bottom of the casting, on account of the tendency of manganese sulphide to segregate to the top of a heavy casting.

In the analysis of cast irons it is essential for accurate work that the drillings or turnings should be graded by sieving, so that aliquot proportions of all sizes of the material comprising the sample should be got in the several portions used for each estimation. This sieving may perhaps be omitted for commercial work in the case of all elements except carbon. In the case of carbon, considerable inaccuracy may result from using portions of the samples which are either rich in fines or rich in large particles, as the fine particles almost invariably contain more graphite than the coarse. An alternative method is to grind the whole sample to a fine powder and mix thoroughly.

Essential Preliminaries.

(1) All glassware and other utensils used for analytical work must be chemical clean. The perfectly clean glass vessel is readily indicated by the entire absence of "tear drops" when any liquid is either poured into it or run out of it. An excellent cleaning mixture consists of a saturated solution of potassium bichromate in concentrated sulphuric acid Graduated glassware such as burettes and the like may be filled with this solution, warmed for preference, and allowed to stand thus for several hours. The solution is run out, and the vessel is then repeatedly washed with distilled water. Some chemists use strong alkali, but such a method tends to dissolve silica from the glass, whereas the chromic acid solution given above has no bad effect on the most delicate glassware.

(2) All reagents must be tested for purity and only reasonably pure chemicals used.

(3) The quantity of any reagent used must be measured or weighed.

(4) A blank determination on all reagents used in any standard method should be made whenever a fresh batch of any reagent is used, hence the necessity for carefully measuring or weighing the quantity of any reagent used.

(5) Care should be taken to check the ash content of each batch of each grade of filter papers used for all filtrations which are to be followed by ignition to constant weight. For most commercial work single acid washed filter papers will be good enough, but for the most accurate work double acid washed filters may be considered necessary. In any case, no filter paper with an ash content of over 0.005 gms. for the 11-c.m. size should be used, as with a higher ash content one is apt to get considerable irregularity.

(6) In the case of volumetric work, great care must be exercised that the solutions have been standardised under exactly similar conditions to those in which they are made use of the actual analysis. Standard cast irons are very valuable in this respect, and in the case of the alloy cast irons, when dealing with such elements as nickel, chromium, etc., it will be found expedient to standardise the solution against a pure nickel or chromium salt to which the necessary amount of a standard cast iron has been added. In metallurgical analytical work the normality of the solution is unimportant, but on the other hand the standard value must be accurately known for any definite set of conditions.

German Ironfounders' Employers' Federation.

SECOND DAY.

We published on July 19 an account of Dr. Geilenkirchen's address on foundry problems, delivered on the first day of the annual general meeting. The morning of the second day was devoted to Federation business and to an inspection of the Danzig shipyards. In the afternoon, a number of interesting surveys of market conditions and economic problems were presented.

Position of the Ironfoundries.

Herr Reuss, speaking on the position of the ironfoundries, said that the latter were, in the main, fairly busy during 1927. Only towards the end of the year did a slight falling off become apparent, which, with certain fluctuations, has continued and, in some cases, made itself appreciably felt.

If, at first, the setback could be attributed in part to normal seasonal slackening of demand, the position at the beginning of the present year showed that the turn of the tide had set in. In spite, however, of the general falling off in the employment of the ironfoundries, the state of affairs could still be regarded as fairly satisfactory. On an average, orders in hand covered a period of four to six weeks, while a number of foundries were booked up for several months.

Apart from a few cases in which complaints were made regarding the quality of pig and coke, no fault could be found with the supply of raw material, and, on the whole, this side of the trade was quite uneventful.

In the year under review, wages underwent heavy increases all over the country. These increases had been particularly evident since April or May last owing to the majority of agreements having then expired. The further burdens of higher wages and salaries, placed upon the foundries by the arbitration awards, have caused the Federation to be faced with a grave problem. The questions whether these fresh increases in overhead charges should, in view of the lessening of demand, be borne on the foundries' own shoulders had to be answered, after thorough examination of the circumstances, in the negative.

Wage Increases Passed On to Consumer.

The well-nigh completely unprofitable years, 1925 and 1926, and the short respite from depression which 1927 brought, had not made it possible for the foundries to carry out such technical improvements as might have enabled them to carry fresh burdens. The arbitration procedure did not permit of sufficient attention being devoted to these circumstances and of their being taken into account in the making of the awards.

Thus it was decided on March 23, 1928, to raise prices—which had remained unaltered for two years—of merchants' castings by 8 per cent., the increase to take effect from May 1. Likewise, the decision of April 26, to raise the prices for engineers' castings by 6 per cent. from May 3, was an absolute necessity, forced upon the Federation by the unfortunate state of things.

As in the case of the last price increase of May 5, 1927, the associations representing the buyers of castings had failed to show any understanding of the position of the foundries and refused to recognise the price increase for engineers' castings. Thus many difficulties had been encountered in giving effect to the new prices. The lecturer claimed, however, that at the time of speaking the higher prices had largely been agreed to by the consumers. Continuing, Herr Reuss gave some particulars of the market conditions as they affected the various classes of castings.

Engineers' Castings.

In the case of engineers' castings, inquiries and orders had both somewhat further declined. Export business was unsatisfactory throughout. Opinions as to the future were divided, but the majority of firms looked forward to no improvement in the next few months.

A somewhat more favourable picture was presented by the market for merchants' castings. In the majority of cases the orders on hand were satisfactory and the coming months were looked upon as likely to bring an improvement. An increased demand which had recently been noticeable had been due to large purchases by wholesalers before prices went up.

Owing to building and constructional works not being carried out on the scale expected, business in builders' castings was disappointing.* The general scarcity of money had hindered the execution of many projects, and prospects for the next few months were rather obscure.

British Competition.

In cast-iron pipes there had been speculative activity due to the price increases, but there was also a genuinely increased demand, which led to the works being better employed. Export business bore a less favourable aspect, as French, Belgian, American and, of late, British competition made things very difficult. The last country, said the lecturer, was not confining itself, as formerly, to the British dominions, but was very evident also on the continent of Europe and in South America—and was selling at prices which would leave no profit for German works. The outlook did not justify very high hopes.

A not ungratifying picture was presented by the export figures for 1927. The quarterly average reached 54,801 tons, thus exceeding for the first time the pre-war export figure of 52,395 tons. The items of which the export figures had exceeded those of 1913 were pipes, and builders' castings coming under the head of finished manufactures. These latter castings accounted for very nearly half the total value, 100 million RM, of foundry products exported in 1927.

In the first quarter of 1928 the increase in exports was maintained, with 57,321 tons, valued at 25.4 million RM. Of this sum, cooking utensils, etc., alone accounted for 12.7 million RM.

Unprotected Markets.

The main countries to which exports were made, said Herr Reuss in concluding his address, were those imposing but a low import tariff on foundry products, the Netherlands, Great Britain and the northern countries. Exports to other destinations showed, it was true, a steady upward tendency since the war but remained far behind the pre-war values.

THE PIG-IRON MARKET.

Herr Director Steinmetz, of the Pig-Iron Association, who dealt with the pig-iron market, stated that the healthier symptoms which became evident in German industry in 1926 developed further in 1927, as no great industrial upheavals occurred in that year to retard progress. The marked improvement in employment of the works in 1927 was due, in no small measure, to rationalisation and plant renewals in the coal and iron industries. The improvement in the iron and coal market brought about by the British coal strike affected the manufacturing industries, whose capacity for absorbing raw materials increased from month to month.

The most striking characteristic of this development was an extraordinarily strong home demand which, in point of quantity, compensated for the limited inquiries for export. A great source of strength to the iron market was the brisk activity in the building and constructional trades.*

In spite of the favourable demand from a quantitative point of view, however, the profit earning capacity of the iron industry left much to be desired, as the overhead expenses were greatly influenced by the arbitrarily imposed conditions relating to wages and hours. These handicaps, in conjunction with the high taxes, expenditure on social services and the burden imposed by the Dawes scheme, had already led to the Pig-Iron Association being compelled to lose a large proportion of the export orders to countries in which overhead costs were much below those with which the German industry was faced.

On the German home market, sales of foundry pig-irons, after a setback in the first quarter of 1927, showed improvement, increasing month by month and reaching, at the end of the year, a satisfactory height.

The import of foreign pig-iron had, unfortunately, considerably increased during 1927: it amounted to about 2½ times that of 1926. The Pig-Iron Association's price policy, which was directed to protecting the market from heavy price fluctuations, offered, when rightly regarded, no occasion for this.

As already indicated, the Pig-Iron Association's export trade had been unsatisfactory during the 1927 economic year. Sales had dropped considerably and prices showed a marked backward movement.

Unhopeful Outlook.

During the first months of the current year pig-iron sales on the home market suffered a reverse, which was not so much due to lessened requirements on the part of the foundries as to the large stocks laid in by the consumers towards the end of 1927. The hope that home sales would again improve had, however, not been fulfilled, and, owing to the difficulties experienced on every hand in connection with wages and hours an element of nervousness and uncertainty had entered the German market, which left but little hope of normal business in the course of the next few months.

THE FOUNDRY SCRAP MARKET.

Herr Director Oloff, of the Gussbruch-Einkauf G.m.b.H., Düsseldorf, presented a report on the foundry scrap market.

While the steel scrap prices were practically the same throughout the year—even at the times of maximum demand—the prices for engineers' castings scrap showed a big upward movement at the end of 1927. In the first four months of 1927 the price difference between steel scrap and foundry scrap amounted to only a few per cent.—according to the diagram of the Gussbruch-Einkauf G.m.b.H. (Foundry Scrap Purchasing Corp.), 3 per cent. At the end of 1927 the price difference had increased to 30 per cent., and, in January-February, 1928, even to more than 33⅓ per cent.

Excessive Price Increases.

It was true that the price curves had in the meantime again approached almost to within 15 per cent. difference, but the fact remained that, while no exploitation had been possible of the closely united and well-organised consumers of steel scrap, the less well-organised users of foundry scrap had had in certain districts to submit to exhorbitant price increases.

The Gussbruch-Einkauf G.m.b.H. had done what was possible to remedy matters by the import of foreign foundry scrap; in addition, they had been able, in conjunction with the steel scrap users' associations, to induce the authorities to prohibit, temporarily, the export of foundry scrap during times of scarcity of this material on the home market.

So long as, in other countries, embargoes existed on the export of scrap, the German users of steel scrap and foundry scrap and their organisations would have to stand up for strict enforcement of the German export prohibition.

The Crown Agents for the Colonies have placed the following orders for locomotives and rolling stock:—For the Kenya and Uganda Railway: Eight Garratt type locomotives, Messrs. Bever, Peacock & Company, Limited, Manchester; and three four-eight-two tender locomotives, the Vulcan Foundry, Limited, Newton-le-Willows, Lancs. For the Tanganyika Railways: Twenty bogie covered goods wagons, the Leeds Forge Company, Limited; eight four-wheeled brake vans, Clayton Wagons, Limited, Lincoln; and six bogie fuel wagons, the Gloucester Railway Carriage and Wagon Company, Limited.

* These "data" fall into Mr. Punch's classification, "Facts which give the historian headache."—Editor.

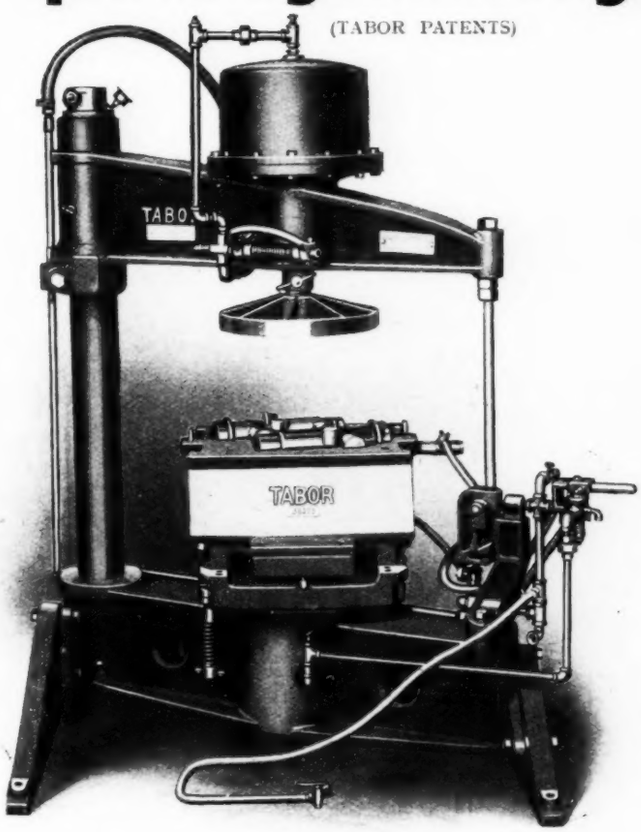
ECONOMY IN THE FOUNDRY

The savings secured by the use of a latest type BRITISH MADE

Jarring Squeezing Moulding Machine

(TABOR PATENTS)

JAR RAMMING ELIMINATES ALL HAND TUCKING AND DOES DEEPER MOULDS



SQUEEZING ELIMINATES FLAT RAMMING

13" Jar Squeezing Pattern Drawing Moulding Machine.

often constitute a highly satisfactory margin of profit on entire plant operation, and definitely

BETTER QUALITY CASTINGS
MORE UNIFORM CASTINGS
GREATER PRODUCTION

We can shew you TABOR MACHINES supplied 30 years ago still working and giving satisfactory service.

OUR MACHINES REPRESENT

Quality—Superior Performance—Efficiency—Low Maintenance Costs—Moderate Prices.

MACNAB & CO.

150, HOLBORN, LONDON, E.C.1

Telephone : 6405 Holborn, London. Telegrams : "OMMACNABRA," LONDON.

Theory or Practice in the Grey Iron Foundry.

(*Continued from page 96.*)

Below further views on this important subject are given by recognised leaders of thought in the industry.

Prof. Dr. ING. PIWOWARKSY, of the Technical High School, Aachen.

I read with great interest Mr. Shaw's Paper which he wrote as reply to some criticisms. The author is quite right when he says that one must sometimes go to extremes to avoid troubles in the practice. In fact, a comparison of the several Papers in this line shows that there are many differences in the results of the several workers, and that there are many problems yet to work out in the future. But I think that Mr. Shaw's criticism is a little too strong, and that it may take away some pleasure in working out further researches. But this strong criticism should have a real success in that the workers will take more pains in the future to work out their experiments according to the demand of practice. In this direction, I think that from time to time a Paper like Mr. Shaw's is very useful for both theory and practice. It is, in fact, very refreshing to read such outspoken criticisms.

Dr. C. H. DESCH, F.R.S., Professor of Metallurgy, the University of Sheffield.

I agree with Mr. Shaw as to his suggested programme of work. It seems to me quite impossible that manganese can have a direct influence in producing graphite, as we know that manganese carbide is particularly stable. It is, however, quite possible that its influence on the critical points may be responsible, as is suggested. This is a matter well worth investigating. As regards the sulphur, it is clear that this element occurs in quite a different form in cast iron and in steel. If it were present as a free sulphide, whether FeS or MnS, I do not see how it could possibly affect the whiteness of the iron, and it seems therefore to be associated with the carbide in some way. Curiously enough, since the work of Coe and others, at the same time, scarcely anything has been done on it. As regards the analytical estimation of sulphur, we should never trust an evolution method for these irons.

Mr. OLIVER SMALLEY, the well-known British Metallurgist, now Domiciled in America.

In regard to the Paper, I consider it unique in its presentation, practical in its form, and enlightening in its facts. It embodies more work than appears at first glance, and one has to know the writer to appreciate its substance. Mr. Shaw has certainly got under the skin, and maybe he will find in criticism that he will have a hornet's nest. However, it can do nothing but good, for I think a practical issue of this nature to establish in the minds of many theoretical metallurgists just where they stand, just where they must start from, and that, maybe, practice has some position in the metallurgy of cast iron.

I think Mr. Shaw very fully justifies his three ideas, and the third is the only one of serious concern so far as I personally am concerned. There appears to be two objects in reading a technical report:—

(1) What had the author in mind?

(2) What is there good in the Paper worthy of attention and development?

I always keep these in front of me when I read any research, and do not allow myself to be sidetracked by side issues.

Mr. J. E. HURST, the Author of the Well-known Book on "The Metallurgy of Cast Iron."

Mr. Shaw's explanation of the influence of manganese fell into line with his own, and this was undoubtedly an example of what Mr. Shaw had in mind when he referred to the danger of drawing conclusions regarding the influence of elements on cast iron based on analogies between their influence in steel. As a result of experiments in connection with steel manganese had been found to form double carbides, and as a result the conclusion had been drawn that manganese was a hardener. In spite of the fact that in most textbooks on cast iron this statement, that manganese must be regarded as a hardener is continuously repeated, it is quite incorrect, and in the presence of silicon, manganese must be regarded as a softener.

In connection with the influence of phosphorus this was always an element of mystery to the foundryman. He (the foundryman) knew that it was much more difficult to break a pig of hematite iron than one of ordinary foundry iron, yet when they are cast into tensile test bars he finds very little difference in the ultimate strength. The mystery was easy to explain when it was considered that the breaking with the hammer and the straight pulling in the tensile machine involved vastly different properties. The complicated stresses to which a pig-iron is subjected in breaking with a hammer involve the property of brittleness or resilience, and it is quite easy to see that although the ultimate strength may be the same the work done or the energy absorbed in bringing about fracture may be considerably greater in the case of the hematite iron than in the case of the phosphoric foundry iron.

It was rather surprising to find that Mr. Shaw had not included the question of dissolved gases in cast iron. It was the one omission he had to comment upon in the Paper, which was an extremely delightful survey of what one might call the metallurgy of cast iron.

Mr. Shaw's proposals for the re-investigation of the properties of cast iron were of merit, and certainly appealed to foundrymen. The outstanding difficulty they had to face was that of explaining the very fundamental fact upon which the whole of the properties and the whole utility of cast iron depended, that is the formation of graphite.

It was futile to undertake a comprehensive investigation upon the lines suggested by Mr. Shaw, until this knowledge is available. Results were of very little value unless they were able to explain and show how those results were to be repeated. Until they had a knowledge of the fundamental phenomenon of the formation of graphite it would be difficult to understand how the results were obtained.

He was sorry to see that Dr. Hanson's investigations had come to a temporary stop. That investigation threw a ray of light on the possibility of an explanation as to the when, where, and why graphite began to form. It was specially gratifying to the foundry community and to the country as a whole to know that the first glimpse of a satisfactory explanation was the work of British investigation.

Dr. W. H. HATFIELD, of the Brown-Firth Research Laboratories.

I esteem it an honour in being asked to air my views upon Mr. Shaw's Paper. The figures quoted from my work are quite correct, and if compared with the rest of the data, show, at any rate on this size of bar, how critical is the effect of the silicon content.

As to the Paper, Mr. Shaw is to be congratulated on his effort, revealing, as it does, not only his extensive knowledge of the subject, but also the fact that he has a full appreciation of all the factors which go to make up that complex quantity known as "cast iron." Further, it is always easy to criticise, but is never so easy to answer criticism. If I am to criticise this latest effort of Mr. Shaw's, it will only be to say that the excellent work of the theorists has perhaps not received its due. Cast iron, containing, as it does, apreciable quantities of six elements, can only theoretically be considered as a sexternary system. The complete study of a ternary system is difficult enough. A complete understanding of a six-fold system, therefore, requires an overwhelming amount of work. It is, in consequence, a great achievement of the theorists to have thrown light on so many of the factors concerning cast iron. That there is still much to be learnt will be conceded, but that does not detract from the work already done.

Is there any likelihood that approach other than from a pure-iron base is going to be fruitful of results? I have my doubts. Whatever additions are made to cast iron (speaking of ordinary cast irons as usually met with) there will still be two types of constituents, (1) ferrite containing more or less other elements in solution, and (2) precipitated components (Fe_3C, graphite, Fe_3P, etc.). Now it is a fact that excepting the enforced solution of C in iron, all other elements when in solution in iron (if not present in more than a small percentage) have very little influence on its tensile properties. The other constituents are all hard and brittle, and their influence depends on their state of distribution. This state of distribution is affected not only by the presence of other elements, but also by the history of the material, viz., melting and casting temperatures, rate of cooling and subsequent heat treatment, if any. Progress is more likely to be made by studying these variables than by a weak attempt at the sexternary system.

I am pretty well in agreement with the remarks made on the effect of the various elements. In the case of manganese, I cannot find justification for some of the author's statements. Both Coe's and Hamasumi's experiments do indicate that even small additions of manganese raise somewhat both the Brinell and tensile strengths. The results quoted indeed all show increased transverse and tensile strength with the higher manganese content. The graphitising action of manganese is very uncertain and unlikely. Coe's complete results indicate a definite increase of stability of the combined carbon with increase in manganese. It is probably all a question of where the manganese is. This element increases the solubility of C in γ iron and will render stable the carbide in solution. If present in the precipitated carbide, however, its action may be different but the evidence of an increased graphitising action with manganese present appears to be small.

There is still much work to be done, and the proposal made by Mr. Shaw will go some further distance on the road to a complete understanding of this complex material. What I criticise in the Paper is the impression (which I received on reading it) of a certain belittling of the work of the theorist and scientific investigator. The fact that the practical man does not always realise perfectly the conditions of these investigations, and jumps from them to his own conclusions, is his own fault and not that of the scientist. The influence of silicon is perhaps a case in point. The general influence of this element is pretty well established, but the actual amount of combined carbon present is affected by so many factors other than the amount of silicon (rate of cooling, size of specimen, melting and casting temperatures, etc.). To quote a series of steels by different investigators with different sizes of bars, and without mentioning all of these factors is hardly expected to yield concordant results, nor is one likely to be able to make use of them

Dr. J. W. DONALDSON, Oliver Stubbs Medallist.

Too many people still use too much silicon. Personal experience has indicated that the silicon should be as low as possible, certainly under 1.1 per cent. It is difficult to agree with Mr. Shaw as to the graphitising effect of manganese. In recent work, however, I have found it to lower the pearlite point quite distinctly; and also that it promotes growth, due probably to the manganese, of the decomposed double carbide of iron and manganese, through oxidation. With reference to phosphorus, I have found that increasing phosphorus from 0.20 to 1.06 per cent. increases the heat-resisting and diminishes the growth properties due to the phosphide eutectic being more stable under heat than the pearlite. The results of these investigations I hope to give in a Paper to the Foundry Conference in Paris in October. Mr. Shaw's scheme of research is very interesting, although long. There is no doubt, however, that to tackle the subject properly one must start from a base and take each element separately. In my present investigation I have attempted to do that in a small way.

XUM

CUPOLA FANS

WHEN you are in need of a Cupola Fan in your Foundry, there is the right size of Sirocco Fan to suit your purpose.

Sirocco Cupola Fans are high in efficiency, strong in construction, and reliable in operation.

Write for Catalogue No. 5.

Davidson & Co., Limited

Sirocco Engineering Works, Belfast.

LONDON, GLASGOW, MANCHESTER, CARDIFF, BIRMINGHAM, BRISTOL, NEWCASTLE.

BLACKING,
PLUMBAGO,
CORE GUM,
WHITE DUST,
COAL DUST.

ESTABLISHED 1863.

JAS. DURRANS & SONS, LTD.

PHOENIX WORKS, PENISTONE, near SHEFFIELD.

Manufacturers of

FOUNDRY EQUIPMENTS

LADLES,	GANISTER,
FIRE BRICKS,	LOAM AND SAND MILLS,
STONE FLUX,	STUDS,
CASTING CLEANERS,	CHAPLETS,
PIPE NAILS,	BRUSHES,
SPRIGS,	CORE ROPES,
WIRE BRUSHES,	BUCKETS,
BELLOWS,	SPADES, Etc.
CUPOLAS,	

Telephone:
21 PENISTONE.

Telegrams:
"DURRANS, PENISTONE."

Write for Illustrated Catalogue on Blacking and Foundry Requisites, also for our latest Price List.

Trade Talk.

The foundries in Yugo-slavia have formed a cartel with a central selling bureau in Agram (Croatia).

Alloy Welding Processes, Limited, have secured a contract from the Admiralty covering the supply of "A.W.P." electrodes during the period July 1, 1928, to June 30, 1929.

Messrs. R. R. Roberts, Limited, Woolfold Ironworks, Bury, are being wound up voluntarily. Mr. A. Chadwick, 16, Bolton Street, Bury, has been appointed liquidator.

Messrs. W. T. Glover & Company, Limited, cable manufacturers, of Trafford Park, Manchester, have removed their Birmingham branch offices to 17, Summer Row.

Messrs. A. H. Rigmaiden, Limited, iron, tinplate and metal merchants, have removed from 4, Chapel Walks to 22, Preeson's Row, Liverpool. The firm's telephone number and telegraphic address remain unchanged.

It is stated that one of the four blast furnaces at the Redbourn Works, Scunthorpe, of Messrs. Richard Thomas & Company, Limited, is to be restarted in September, and a second one in November. The management hope to get the steel plant running early in December. The coke ovens are already working.

An order for a new crane to be erected at Glasgow Harbour has just been placed by the Clyde Navigation Trust with Messrs. Cowans, Sheldon & Company, Limited, Carlisle. The crane, which will be electrically operated, will be capable of lifting weights up to 175 tons. It will be designed on the cantilever principle, and the cost will be £51,887.

The Bombay, Baroda and Central India Railway Company have awarded the Sentinel Wagon Works, Limited, Shrewsbury, a contract for three "Sentinel-Cammell" steam rail cars, and the same firm has received from the Southern and London, Midland and Scottish Railway Companies, acting on behalf of the Somerset and Dorset Joint Railway, a contract for two 200-h.p. industrial-type locomotives.

Messrs. Ransomes & Rapier, Limited, Ipswich, have recently obtained several orders for large breakdown cranes. They include four 75-ton steam breakdown cranes of the "Stokes" relieving bogie type for the Bengal-Nagpur Railway, India; a 40-ton "Stokes" type breakdown crane for the Sorocabana Railway, Brazil; one 80-ton crane for the South Manchurian Railway, Manchuria; and a 35-ton crane for the Great Indian Peninsula Railway.

The Societe Francaise des Acieries Basset reports for 1927 a loss of 2,691,372 fcs. The past year has proved to be a most disastrous one for the Company. The cement-producing branch of the Company has been doing well, but at the expense of the iron and steel-making branch. However, the process for making pig-iron direct from the ore is said to have been greatly improved, and the use of hand labour has been almost completely replaced by machinery. As regards steel-making, all the details for the industrialisation of the process are now claimed to have been perfected.

The Derwent Valley Water Board, which has gathering grounds and reservoirs over a wide area of Derbyshire, has decided to duplicate an important section of its steel pipe-line between Bamford filters and the service reservoirs at Ambergate. So that the work may be facilitated during the fine weather, the pipe-line, which will consist of 47-in. steel mains, will be laid in three sections. The contract has been placed with a Plymouth firm, for £58,000, and it is understood the work will be completed in about twelve months' time.

An agreement was reached at a meeting in Glasgow between the employers and the trade unions in the light castings industry regarding the application of the National Light Castings Association for a decrease in wages. The reductions, which are subject to ratification by a ballot of the men, include 2s. 6d. per week from piece workers, 1s. 6d. per week from time workers, and 1s. per week from labourers. The reductions are considerably less than the employers originally suggested. The reductions will take effect from September 1.

Sir F. Boyd Merriman, the Solicitor-General, speaking at Bolton, said that in the cost of every ton of steel there was 4s. for rates, and in the proposed Government relief measure the removal of three-quarters of the rating on the works would reduce the cost of production by 3s. a ton. In addition, the steel industry, he said, would also benefit by the easing of the burden of railway rates on the products necessary to the industry. The relief in coal alone would be something like 10½d. a ton, and altogether the steel industry would be relieved to the extent of about 4s. 6d. a ton in the cost of production.

The Campbell Gas Engine Company, Limited, of Halifax, one of the most important manufacturers of gas and oil engines, has been purchased by Messrs. George Cohen, Sons & Company, Limited, of London. Mr. George Levy, a director of the purchasing company, who after the war took over the final disposal of the British Government stock of surplus stores and machinery, stated that, if his company decided to carry on the business, many important changes would certainly have to be made in the Campbell organisation to effect economies, as has been done in the case of the Kryn and Lahy Steel Foundry, which his company purchased early this year.

Mr. Ernesto C. Perez, the Argentine Consul-General in this country, visited Middlesbrough recently. The demand in the Argentine for British steel, he said, was rapidly increasing, and his country was becoming one of the best customers of the Tees-side iron and steel manufacturers. Steel, however, must be offered at a competitive price. That was where Great Britain had showed a tendency to drop behind. When the finest steel in the world was required the Argentine imported British steel; but often a slightly cheaper grade would suffice, and then the New World bought steel from Germany and the United States. It was the great hopes of the Argentine that some day England would produce steel at a price that would enable every user of it in South America to place the order with English firms. There was no doubt at all about the Argentine's implicit trust in the unvarying high quality of British steel, but often they were forced to accept tenders from the United States because of the difference in price.

Obituary.

Mr. John R. Bell, managing director of the Bolton Railway Wagon and Ironworks Company, Limited, died at his residence in Bolton on August 1.

Mr. Arthur A. Peech, for many years a director of Messrs. Steel, Peech & Tozer, Limited, Ickles, Sheffield, died recently.

Mr. Robert Ayile, of Alfred Street, Ripley, has died at the age of 87. Though an architect by profession, he commenced his career at the Butterley Ironworks.

We regret to announce that Rear-Admiral T. B. S. Adair died at a Glasgow nursing home last Sunday at the age of 66. His connection with the engineering industry started in 1907, when he was made superintendent of the gun department at the Parkhead Steelworks of Messrs. W. Beardmore & Company. He retired in 1918 on being elected to Parliament.

Company Meetings.

National Smelting Company, Limited.—The tenth annual meeting was held in London recently. The Rt. Hon. Sir Robert Horne, M.P. (the chairman), who presided, said that the value of zinc, which averaged in 1926 £34 2s. 8d. per ton, averaged only £28 9s. 10d. in 1927, and the averages for lead for the same years were £31 2s. 1d. and £24 8s. respectively. These were very substantial reductions, and had had their effect on the receipts. They had carried out a great deal of metallurgical investigation with the object of improving their work. The efforts of the staff had been attended with a substantial measure of success, and they were confident that their metallurgical position had, in consequence, been very greatly strengthened. No body of metallurgists in the world was, so far as they knew, ahead of them to-day in scientific knowledge in their particular branches of manufacture. Their operations at Avonmouth and Swanseavale continued to expand. The tonnage of concentrates treated in 1927 was a record, and this year, down to the present date, they showed further substantial gains. They expected to make even greater headway, and to give further employment to the largest extent which was economically possible. The results from their works and also from their investments were influenced by metal prices, and these were still depressed, although the general outlook for them was somewhat less uncertain. He ventured to predict a year ago that wise co-operation among zinc producers would materially speed up the adjustment of market conditions, and it was interesting to note that definite steps in this direction had been taken. He expected good results to follow. He suggested that there was an opportunity for profitable regulation of the production and selling of lead. The world's resources of lead and zinc were being used in an almost prodigal manner, and present production was not only out of balance with the world's resources, but with market requirements. There was, in consequence, much needless waste. The situation demanded the most careful consideration by all concerned. Their own position as regards the supply of raw material was satisfactory and had been strengthened during the year. Their policy was still further to reinforce it, as and when opportunity offered. With regard to the company's small colliery in South Wales, the chairman said that after full investigation by independent experts they were reluctantly forced to the conclusion that this property gave no promise to them of profitable results, and they had therefore closed it down and abandoned the leases.

Zinc Corporation, Limited.—The seventeenth ordinary general meeting of the shareholders of the Zinc Corporation, Limited, was held at River Plate House, Finsbury Circus, London, E.C. The Right Hon. Sir Robert Horne, G.B.E., K.C., M.P. (chairman), who presided, reminded the shareholders that last year he dealt at some length with the position of lead and spelter, and pointed out that, in his opinion, they were "confronted by the likely prospect of a period of irregularity in prices, with average levels substantially below those of the past few years"—the result of a rapid increase in production with no corresponding improvement in consumption. Regarding the world's production of lead and spelter, they were as follow, in long tons:—Lead: 1924, 1,301,502; 1925, 1,463,500; 1926, 1,538,500; 1927, 1,657,500. Spelter: 1924, 1,004,500; 1925, 1,128,500; 1926, 1,263,000; 1927, 1,308,100. The chief increases had been in Mexico and in Canada. Up to the year 1925 the world's lead production was strained to meet consumption and prices were high; but when consumption became stationary while production was increasing, supply and demand got out of balance and values suffered severely. The extent to which they had suffered could be readily realised from figures which showed that the value of the 1925 production based on the average price of that year was £52,602,000, while the value of the 1927 production on the price of July, 1928, was only £33,978,000. Thus it would be seen that production at the rate of 194,000 tons of lead per annum more than in 1925 reduced the total value of the world's output by over £18,500,000, or, say, 35 per cent. That provided food for thought. The movements of the markets afforded ample evidence that the consumers of the world could not yet comfortably absorb production of the volume of 1926 and 1927, while, on the other hand, there was abundant proof that the world's resources of lead and zinc could not suffer for any great length of time the enormous drain that was being made annually upon them by producers. There appeared to be a very good case indeed for considering better regulation of market supplies, and, if need be, regulation of production. Owing to the fall in metal prices, they had restricted development, as from June last, to work essential to maintain good ventilation and to open up sufficient ore for the maintenance of elastic mining conditions, so essential for economic extraction. Despite this restriction, it was gratifying to record the satisfactory increase in ore reserves of 159,646 tons. This brought their reserves to a total of 2,626,707 tons, containing 14.6 per cent. lead, 3.1 ozs. silver and 10.7 per cent. zinc. These figures did not include the zinc lode, the tonnage for which had also been increased to a total of 245,696 tons, containing 6.4 per cent. lead, 1.4 ozs. silver, and 18.1 per cent. zinc. In the past, when metal prices were high and profits substantial, they had been very liberal in their development expenditure, all of which they had charged against profits. As a result, they had added greatly to their reserves and improved their underground position.

New Companies.

Fleet Castings, Limited, 148, Edmund Street, Birmingham.—Capital £1,000. Brass casters, etc.

Wigan Castings, Limited, Alfred Street, Platt Bridge, Wigan.—Capital £6,000. Directors: A. Clarke, A. Cochrane, H. Gorman and G. Hunter.

Beverley Works, Limited, Willow Avenue, Barnes, S.W.—Capital £30,000. Engineers, etc. Directors: C. G. A. Dolphens, A. Flamand and P. Lenaerts.

C. E. Holdsworth, Limited, 53, Bradford Road, Stanningley, Yorks.—Capital, £1,000. Machine and metal brokers, etc. Directors: Agnes Busfield and A. Holdsworth.

Wellbrook Engineering Company, Limited, 36, Wellbrook, E.C.4.—Capital £3,000. Iron, steel or other metal refiners, etc. Directors: A. Durrans, I. J. G. Bubbage and C. H. Brand.

John Brown & Partners (Peckham), Limited.—Capital £1,800. Ironfounders, etc. Directors: Mary A. Morgan, G. D. Morgan and J. M. Clutterbuck. Solicitors: Wainwright, Pollock & Company, 9, Bush Lane, E.C.4.

Contract Open.

Cradley Heath, August 25.—Construction of about 408 yards of 22 in., 800 yards of 16 in., and 660 yards of 15-in. cast-iron pipe sewers, etc., for the Upper Stour Valley Main Sewerage Board. The engineer, Mr. G. Plant Deeley, 13, Church Street, Stourbridge. (Fee £3 3s., returnable.)

"SERVICE GRC FIRST"

ALL YOUR NEEDS
IN
REFRACTORIES
AND MINERALS
CAN BE AMPLY FILLED BY
The General Refractories Co. Ltd.
SHEFFIELD.

Enquiries are cordially invited and will be promptly and courteously answered. Expert technical advice on Refractological matters is offered free.

SANDS — GANISTER — FIREBRICKS — SILICAS —
MAGNESITES — COROMA & CHROME BRICKS —
FIRE CEMENTS—CORE BINDERS—COMPOSITIONS
LIMESTONE—FLUORSPAR—LIME—DOLOMITE, Etc.

MONOMARK:

BCM / REFRACTORY
LONDON.

Telegrams: Refractory, Sheffield. *Telephone: 22311 Sheffield.*

Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—Although nominally business has been resumed this week in the Cleveland iron market, very little actual interest has been taken in the proceedings, due largely to the absence of most of the prominent operators now away holiday-making, and perhaps equally affected by the entire lack of profitable opportunity, whether as buyers or sellers, in the abnormal conditions prevailing in the industry. It is now regarded as hopeless in market circles to expect any revival of activity of demand from home consumers until September at the earliest, and that even must be dependent upon a marked improvement in the foundry trade generally, of which there are no favourable signs at present. Turning to the export side, the prospects of an improved foreign trade appear to be hopeful. July exports showed an advance on the June figures, and the improvement has been maintained, 3,875 tons of pig-iron having been despatched from the Tees during the first week in August. Meanwhile, quotations continue absolutely rigid, the following being the fixed minima both for home sales and for export:—No. 1 Cleveland foundry iron, 68s. 6d.; No. 3 G.M.B., 66s.; No. 4 foundry, 65s.; No. 4 forge, 64s. 6d. per ton.

Energetic efforts have been made by makers of hematite in the Tees-side area to reduce the accumulations of stocks in hand, and now that these stocks have been brought down to reasonable proportions, the makers are naturally seeking to advance prices at least to the level of the actual cost of production. Most makers are holding out for 70s. per ton for mixed numbers, with No. 1 quality at a premium of 6d. per ton, and it is not easy to find sellers below these figures. On the North-West Coast Bessemer mixed numbers remain at 68s. per ton at works.

LANCASHIRE.—During the current holiday month both buying and selling movements in the local markets for foundry pig are as usual restricted within very limited compass, with but little disturbances of prices in either direction. Quotations accordingly rule about as follow:—Staffordshire No. 3, 67s. 6d.; Derbyshire, 68s.; Cleveland, 79s.; Scottish, from 87s. 6d. to 90s., including delivery in each instance to works in the Manchester area.

THE MIDLANDS.—Buying in the local markets for foundry pig is virtually suspended, except for occasional parcels to meet urgent requirements, and these conditions are likely to continue for a few weeks longer, until the autumn is further advanced. Quotations meantime remain as follow:—No. 3 Northamptonshire is 55s. and Derbyshire 59s. to 60s., with North Staffordshire No. 3 at about the same level as Derbyshire, all at furnace. Scotch No. 3 is quoted at about 89s. delivered locally.

SCOTLAND.—The slight improvement in demand which developed recently in the market for Scotch iron has been somewhat counteracted by the holidays in England, and little new business is passing at the moment, prices remaining unchanged at 70s. 6d. for No. 3 quality, f.o.t. furnaces.

Finished Iron.

Most of the Black Country ironworks having been closed for holidays, business in this section of the market is without significance at the moment. The local bar mills are experiencing keen competition from Lancashire and Derbyshire makers for business in crown iron, the price of which varies considerably from £9 to £10. Local nut and bolt iron is offered at about £8 17s. 6d., but lower prices than this are being taken in other directions. There is, however, very little business being done in this class of iron because of foreign competition. Belgian No. 3 iron is quoted at £6 15s. delivered works in the Darlaston district, and business is being done at this price. The makers of Staffordshire marked bars are only moderately occupied, but the price of £12 basis at works is maintained.

Steel.

This is hardly the time of year when much activity is expected in the steel industry, and generally works are marking time until the contract season reopens in September. At Sheffield the demand for acid billets continues very quiet, and basic billets are in smaller request than of late. Open-hearth steel production has not been further modified, and some of the biggest plants here are running not far short of capacity. Continental prices of semis are upheld, but British makers are able to offer inducements to consumers, both in the way of values and deliveries, in opposition to their foreign competitors. Considerable tonnages of Belgian semis, however, continue to be imported. Business in the tinplate market is quiet, without much change in quotations, which range from 18s. to 18s. 1½d. basis, net cash, f.o.b. Wales.

Scrap.

The volume of demand for this class of foundry material has been, as usual, diminished by seasonal causes, while prices remain much at the levels maintained of late in the principal markets. For the better class quality of machinery cast-iron scrap 66s. per ton is still quoted at Middlesbrough, while in Scotland similar material suitable for foundry cupolas ranges from 65s. to 66s., and heavy cast iron to the same specification is named at 61s. 6d. to 62s., light cast iron having declined to 56s., all per ton delivered f.o.t. consumers' works.

Metals.

Copper.—With a somewhat restricted consumptive demand, values of warrant copper are apparently unaffected, and markets continue steady both for cash and forward account. The consistent steadiness of values in spite of depressing influences provides, moreover, the best possible evidence of the confidence which is still felt in the forward outlook and in the strength of the statistical position. With the continued expansion of the electrical industries, which are necessarily the principal consumers, it is difficult to see how any real decline in the world demand for copper can be anticipated for some time to come.

Closing quotations are:—

Cash.—Thursday, £62 7s. 6d. to £62 10s.; Friday, £62 7s. 6d. to £62 10s.; Monday, £62 7s. 6d. to £62 8s. 9d.; Tuesday, £62 8s. 9d. to £62 10s.; Wednesday, £62 7s. 6d. to £62 8s. 9d.

Three Months.—Thursday, £62 17s. 6d. to £62 18s. 9d.; Friday, £62 17s. 6d. to £62 18s. 9d.; Monday, £62 17s. 6d. to £62 18s. 9d.; Tuesday, £62 17s. 6d. to £62 18s. 9d.; Wednesday, £62 17s. 6d. to £62 18s. 9d.

Tin.—The issue of the July statistics, indicating an increase of 1,600 tons in visible supplies, has resulted in a further depression of tin values, and at the close last week cash quotations were well below the previous week's opening rates. The increase in visible supplies, however, is probably more than offset by the known decrease in invisible holdings, and this fact would doubtless be more generally appreciated if it were not for the temporary absence of any general buying movement. However, for the moment the market is ruled by sentiment and by a somewhat spasmodic speculative interest, and it is still possible that a new low level in tin prices will be set up before the inevitable appreciation sets in.

Official closing prices:—

Cash.—Thursday, £215 5s. to £215 10s.; Friday, £215 15s. to £215 17s. 6d.; Monday, £213 10s. to £213 15s.; Tuesday, £212 17s. 6d. to £213; Wednesday, £213 10s. to £213 15s.

Three Months.—Thursday, £212 10s. to £212 15s.; Friday, £213 to £213 5s.; Monday, £211 7s. 6d. to £211 10s.; Tuesday, £210 12s. 6d. to £210 15s.; Wednesday, £210 5s. to £210 17s. 6d.

Spelter.—A rather more active demand for ordinary spelter has developed of late, but without much effect upon prices, which remain steady at about last week's levels. The forward outlook is somewhat obscure except in the case of electrolytic, where the readjustment of world production would seem to be making an appreciation almost inevitable.

Daily quotations are:—

Ordinary.—Thursday, £24 8s. 9d.; Friday, £24 7s. 6d.; Monday, £24 7s. 6d.; Tuesday, £24 8s. 9d.; Wednesday, £24 12s. 6d.

Lead.—A slight improvement in the statistical position has helped to maintain values of late in this section of the market, and quotations are rather firmer in tendency this week. There is considerable speculation as to the probable effect on world lead markets of the Lead Industries' Association, which is reported to have been formed recently in New York. The Association will from the outset embrace both producers and consumers throughout Canada and the United States, and is credited with the intention of extending its scope still further.

Closing prices:—

Soft Foreign Prompt.—Thursday, £21 2s. 6d.; Friday, £21 5s.; Monday, £21 7s. 6d.; Tuesday, £21 13s. 9d.; Wednesday, £21 13s. 9d.

Book Review.

Rating of Machinery and Plant—Position in July, 1928, by J. S. Henderson, B.Sc., Barrister-at-Law. Published by the Argus Press, Limited, 1, Dr. Johnson's Buildings, Temple, London, E.C.4. Price 5s.

We would advise the layman to start reading this book at page 27, unless he is already *au fait* with the subject of valuation for rating. So far as foundries are concerned we gather (though we would not go so far as to guarantee our opinion) that cupolas and stoves are rateable if they form part of a structure or building. Such plant as dust collectors, installed by a Home Office order, is, we gather, "rateable," which seems a little unjust to our mind. As the cost of the book is only 5s., it is obvious that if it shows the way to obtain any relief, it is dirt cheap at the price.

THE WELSH NAVIGATION STEAM COAL CO., LTD.,
PROPRIETORS AND SHIPPERS OF
WELSH NAVIGATION
SPECIAL FOUNDRY COKE
as used in many of the principal Foundries in this Country and abroad.
Sulphur Content .... ·50% or under. Ash .... 6% or under.
Please address enquiries to:
THOMAS & DAVEY, LTD., Cambrian Buildings, Cardiff.
(*Sole Sales Agents.*)
Midland Agency:
W. C. M. JAMES, Exchange Buildings, Birmingham.

Make full use of
The Bradley Service

Bradley's
PIG IRON

"A QUALITY FOR EVERY REQUIREMENT"

Write or 'phone for particulars of the Bradley range of Refined Pig Irons. Immediate attention is given to all enquiries and the knowledge and long experience of Bradley's is at the disposal of all foundrymen.

BRADLEY & FOSTER Lᵀᵈ B&F DARLASTON, STAFFS.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash ..	62	7	6
Three months ..	62	17	6
Electrolytic	68	15	0
Tough	65	0	0
Best selected ..	64	15	0
Sheets	94	0	0
India	76	15	0
Wire bars	69	5	0
Do. August ..	69	5	0
Do. September ..	69	5	0
Ingot bars	69	5	0
H.C. Wire rods ..	73	7	6
Off. av. cash, July ..	62	18	4 3/32
Do. 3 mths., July ..	63	3	9
Do., Sttlmnt., July	62	18	3 5/32
Do., Electro, July ..	68	18	4 1/32
Do., B.S., July ..	66	3	7 1/4
Aver. spot price, copper, July	62	18	4 1/2
Do., Wire bars, July	69	3	5
Solid drawn tubes			13 1/2d.
Brazed tubes			13 1/2d.
Wire			10d.

BRASS.

Solid drawn tubes	11 1/2d.
Brazed tubes	13 1/2d.
Rods, drawn	10 1/2d.
Rods, extd. or rlld. ..	7 1/2d.
Sheets to 10 w.g. ..	10 1/2d.
Wire	9 1/2d.
Rolled metal	9 1/2d.
Yellow metal rods	7 1/2d
Do. 4 × 4 Squares ..	8d.
Do. 4 × 3 Sheets ..	8 1/2d

TIN.

		£	s.	d.
Standard cash ..		213	10	0
Three months ..		210	5	0
English		211	0	0
Bars		213	0	0
Straits ..	(Nom.)	216	17	6
Australian ..	(Nom.)	216	17	6
Eastern		214	0	0
Banca	(Nom.)	218	17	6
Off. av. cash, July ..		212	10	11 13/32
Do., 3 mths., July		209	14	10 7/32
Do., Stlmt., July		212	10	2 5/32
Aver. spot, July ..		212	10	11 1/2

SPELTER.

	£	s.	d.
Ordinary	24	12	6
Remelted	23	5	0
Hard	19	15	0
Electro 99.9	28	15	0
English	24	17	6
India	21	5	0
Zinc dust	33	0	0
Zinc ashes	8	0	0
Off. aver., July ..	24	19	2 5/32
Aver., spot, July ..	24	18	11

LEAD.

	£	s.	d.
Soft foreign ppt. ..	21	13	9
English	23	0	0
Off. average, July ..	20	15	5 23/32
Average spot, July ..	20	11	11 1/2

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	33	0	0
Do. V.M. ex whf.	31	5	0
Rods	39	0	0
Boiler plates	29	0	0
Battery plates ..	30	10	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	59	0	0
Chinese	39	7	6
Crude	33	10	0

QUICKSILVER.

	£	s.	d.
Quicksilver	22	15	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s.	d.
Ferro silicon—			
25%	8	0	0
45/50%	12	5	0
75%	19	7	6
Ferro-vanadium—			
35/50%	14/- lb. Va.		
Ferro-molybdenum—			
70/75% c. free ..	4/3 lb. Mo.		
Ferro-titanium—			
23/25% carbonless ..	1/2 lb.		
Ferro-phosphorus, 20/25%	£18	0	0
Ferro-tungsten—			
80/85%, c. fr.	1/3 lb.		
Tungsten metal powder—			
98/99%	1/7 lb.		
Ferro-chrome—			
2/4% car.	£30	0	0
4/6% car.	£21	10	0
6/8% car.	£20	15	0
8/10% car.	£20	2	6
Ferro-chrome—			
Max. 2% car.	£33	0	0
Max. 1% car.	£38	0	0
Max. 0.70% car.	£44	0	0
70% carbonless	1/1 lb.		
Nickel—99% cubes or pellets	£175	0	0
Ferro-cobalt	9/- lb.		
Aluminium 98/99% ..	£100	0	0
Metallic chromium—			
96/98%	2/8 lb.		
Ferro-manganese (net)—			
76/80% loose	£13	15	0
76/80% packed	£14	15	0
76/80% export	£13	10	0
Metallic manganese—			
94/96% carbonless ..	1/6 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0	2	3
Finished bars, 18% tungsten	£0	2	9

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to ⅛ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ¼ in.	3d. lb.
Do., under ¼ in. × ¼ in. ..	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

Scrap from high-speed tool steel—

Scrap pieces	3d.
Turnings and swarf ..	1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales—						
Hvy. steel				3	7	6
Bundled steel and shrngs. ..	3	2	6	to 3	5	0
Mixed iron and steel ..	3	0	0	to 3	2	6
Heavy cast iron	2	18	0	to 3	0	0
Good machinery for foundries				3	2	6
Cleveland—						
Heavy steel				2	15	0
Steel turnings				2	8	6
Cast iron borings ..				2	3	0
Heavy forge				3	10	0
Bushelled scrap				3	2	6
Cast-iron scrap				3	1	0
Lancashire—						
Cast-iron scrap				3	0	0
Hvy. wrought				2	17	6
Steel turnings				2	2	6

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	52	0	0
Brass	37	0	0
Lead (less usual draft) ..	18	0	0
Tea lead	16	0	0
Zinc	15	0	0
New aluminium cuttings ..	66	0	0
Braziery copper	47	0	0
Gunmetal	47	0	0
Hollow pewter	150	0	0
Shaped black pewter ..	105	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	68/6
Foundry No. 3	66/6
Foundry No. 4	65/-
Forge No. 4	64/6
Hematite No. 1	70/6
Hematite M/Nos.	70/-
N.W. Coast—	
Hem. M/Nos. d/d Glas. ..	79/-
,, d/d Birm.	85/-
Midlands—	
Staffs. common*	67/6
,, No. 4 forge ..	56/-
,, No. 3 fdry.	60/-
Shrops. basic	—
,, Cold blast, ord.* ..	—
,, ,, roll iron* ..	—
* d/d Birmingham.	
Northants forge	51/6
,, fdry. No. 3 ..	55/-
Derbyshire forge	59/-
,, fdry. No. 3 ..	59/6
,, basic	60/-
Scotland—	
Foundry No. 1	75/6
,, No. 3	70/6
Hem. M/Nos.	74/-
Sheffield (d/d district)—	
Derby forge	62/6
,, fdry. No. 3 ..	64/6
Lincs. forge	62/6
,, fdry. No. 3 ..	64/6
E.C. hematite	80/6
W.C. hematite	83/6
Lincs. (at furnaces)—	
Forge No. 4	58/-
Foundry No. 3	60/-
Basic	58/6
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3 ..	68/-
Northants foundry No. 3 ..	—
Dalzell, No. 3 (special)	100/- to 102/6
Summerlee, No. 3 ..	87/6
Glengarnock, No. 3 ..	87/6
Gartsherrie, No. 3 ..	87/6
Monkland, No. 3 ..	87/6
Shotts, No. 3	87/6

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.) nom.	9	10	0	to 10	15	0
Nut and bolt iron	8	12	6	to 8	17	6
Hoops				11	10	0
Marked bars (Staffs.) f.o.t.				12	0	0
Gas strip				11	10	0
Bolts and nuts, ¾ in. × 4 in.				15	5	0
Steel—						
Ship plates ..	8	7	6	to 8	12	6
Boiler plts.				10	10	0
Chequer plts.				10	12	6
Angles				7	17	6
Tees				8	17	6
Joists				7	17	6
Rounds and squares, 3 in. to 5½ in.				8	17	6
Rounds under 3 in. to ¾ in. (Untested)				7	15	0
				and upwards		
Flats, over 5 in. wide and up				8	7	6
Flats, 5 in. to 1½ in. ..				7	17	6
Rails, heavy				8	10	0
Fishplates				12	10	0
Hoops (Staffs.)				10	0	0
Black sheets, 24g. ..				10	0	0
Galv. cor. shts., 24g. ..				13	10	0
Galv. fencing wire 8g. plain				12	10	0
Billets, soft	6	0	0	to 6	10	0
Billets, hard	7	2	6	to 7	12	6
Sheet bars				6	0	0
Tin bars				6	0	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 2½
Sheet to 10 w.g.	1 3
Wire	1 3½
Rods	1 3
Tubes	1 7½
Castings	1 2

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising ..	9d. to 1/3
Rolled—	
To 9 in. wide ..	1/3 to 1/9
To 12 in. wide ..	1/3½ to 1/9½
To 15 in. wide ..	1/3½ to 1/9½
To 18 in. wide ..	1/4 to 1/10
To 21 in. wide ..	1/4½ to 1/10½
To 25 in. wide ..	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila. ..	20.26
No. 2 foundry, Valley	16.50
No. 2 foundry, Birm.	15.50
Basic	17.76
Bessemer	18.76
Malleable	18.76
Grey forge	18.01
Ferro-mang. 80% d/d	105.00
O.-h. rails, h'y at mill	43.00
Bess billets	32.00
O.-h. billets	32.00
O.-h. sheet bars	32.00
Wire rods	42.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.85
Tank plates	1.85
Beams, etc.	1.85
Skelp, grooved steel	1.85
Skelp, sheared steel	1.85
Steel hoops	2.20
Sheets, black, No. 24	2.60
Sheets, galv., No. 24	3.40
Sheets, blue an'l'd., 9 and 10 ..	2.00
Wire nails	2.55
Plain wire	2.40
Barbed wire, galv.	3.20
Tinplates, 100 lb. box	$5.25

COKE (at ovens).

Welsh foundry	—
,, furnace	21/6
Durham and North.	
,, foundry	14/6 to 15/6
,, furnace	14/- to 14/3
Other Districts, foundry ..	—
,, ,, furnace (basis) ..	12/-

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes ..	20×14 box	18/-	to	18/1½
,, ..	28×20 ,,	..		36/-
,, ..	20×10 ,,	..		27/-
,, ..	18½×14 ,,	..		18/9
C.W.	20×14 ,,	..		17/-
,, ...	28×20 ,,	..		34/-
,, ...	20×10 ,,	..		21/9
,, ...	18½×14 ,,	..		15/6
Terneplates ..	28×20	33/6 per box basis f.o.b.		

SWEDISH IRON.

Bars, hammered, £17 10 0	to £18 10 0
Rolled Ord. .. £15 0 0	to £15 10 0
Nail rods .. £15 7 6	to £15 15 0
Keg. steel nom.	£33 to £35
Faggot steel nom. ..	£22 to £25
Blooms, according to quality	£8 to £12
Pig-iron .. £5 15 0	to £6 0 0

2½ f.o.b. Gothenburg.

TUBES AND FITTINGS.

Up to and incl. 6 in.

	Tubes.	*Fittings.*
Gas	67½%	50%
Water	63½%	45%
Steam	60%	40%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£ s. d.	
Aug. 9	62 7 6	No change
,, 10	62 7 6	,, ,,
,, 13	62 7 6	,, ,,
,, 14	62 8 9	inc. 1/3
,, 15	62 7 6	dec. 1/3

Electrolytic Copper.

	£ s. d.	
Aug. 9	68 15 0	No change
,, 10	68 15 0	,, ,,
,, 13	68 15 0	,, ,,
,, 14	68 15 0	,, ,,
,, 15	68 15 0	,, ,,

Standard Tin (cash).

	£ s. d.	
Aug. 9	215 5 0	inc. 37/6
,, 10	215 15 0	,, 10/-
,, 13	213 10 0	dec. 45/-
,, 14	212 17 6	,, 12/6
,, 15	213 10 0	inc. 12/6

Tin (English ingots).

	£ s. d.	
Aug. 9	213 5 0	inc. 35/-
,, 10	213 15 0	,, 10/-
,, 13	211 15 0	dec. 40/-
,, 14	211 0 0	,, 15/-
,, 15	211 10 0	inc. 10/-

Zinc Sheets (English)

	£ s. d.	
Aug. 9	33 0 0	No change
,, 10	33 0 0	,, ,,
,, 13	33 0 0	,, ,,
,, 14	33 0 0	,, ,,
,, 15	33 0 0	,, ,,

Spelter (ordinary).

	£ s. d.	
Aug. 9	24 8 9	dec. 1/3
,, 10	24 7 6	,, 1/3
,, 13	24 7 6	No change
,, 14	24 8 9	inc. 1/3
,, 15	24 12 6	inc. 3/9

Lead (English).

	£ s. d.	
Aug. 9	22 10 0	No change
,, 10	22 10 0	,, ,,
,, 13	22 15 0	inc. 5/-
,, 14	23 0 0	,, 5/-
,, 15	23 0 0	No change

AVERAGE MONTHLY PRICES OF STEEL SHIP PLATES (NORTH OF ENGLAND).

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1896.....	5 0 0	5 0 0	5 2 6	5 2 6	5 2 6	5 0 0	5 0 0	5 0 0	5 0 0	5 2 6	5 10 0	5 10 0	5 2 6
1897.....	5 10 0	5 10 0	5 10 0	5 7 6	5 2 6	5 2 6	5 0 0	5 0 0	5 0 0	5 0 0	5 7 6	5 10 0	5 5 5
1898.....	5 10 0	5 8 9	5 8 9	5 10 0	5 16 3	5 18 9	5 17 6	6 0 0	6 2 6	6 5 0	6 10 0	6 0 0	5 18 6½
1899.....	6 15 0	7 0 0	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 12 6	7 12 6	7 12 6	7 12 6	6 15 0	7 6 5½
1900.....	8 0 0	8 0 0	8 2 6	8 5 0	8 7 6	8 7 6	8 7 6	8 0 0	8 0 0	8 0 0	7 10 0	7 0 0	8 0 0
1901.....	6 15 0	6 15 0	6 5 0	6 0 0	6 0 0	6 0 0	6 0 0	6 5 0	6 7 6	6 5 0	6 0 0	6 0 0	6 4 4
1902.....	5 17 6	5 12 6	5 15 0	5 15 0	5 15 0	5 15 0	5 15 0	5 15 0	5 15 0	5 15 0	5 15 0	5 10 0	5 14 7½
1903.....	5 10 0	5 10 0	5 15 0	6 0 0	6 0 0	6 0 0	5 12 0	5 12 6	5 12 6	5 12 6	5 12 6	5 10 0	5 13 11
1904.....	5 7 6	5 10 0	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 11 10
1905.....	5 15 0	5 17 6	5 17 6	5 17 6	5 17 6	5 17 6	5 17 6	5 17 6	6 0 0	6 10 0	7 0 0	7 0 0	6 2 3½
1906.....	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 10 0	7 0 10½
1907.....	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 9	7 10 0	7 10 0	7 10 0	7 10 0	7 0 0	7 0 0	7 8 4
1908.....	6 10 0	6 10 0	6 10 0	6 5 0	6 5 0	6 5 0	6 0 0	6 0 0	6 0 0	6 0 0	6 0 0	6 0 0	6 3 9
1909.....	6 0 0	6 0 0	6 0 0	6 0 0	6 0 0	5 15 0	5 15 0	5 15 0	6 0 0	6 0 0	6 0 0	6 0 0	5 18 9
1910.....	6 5 6	6 5 0	6 7 6	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 15 0	6 15 0	6 15 0	6 10 2
1911.....	6 15 0	6 15 0	6 15 0	6 15 0	6 15 0	6 15 0	6 15 0	6 15 0	6 15 0	6 15 0	6 15 0	6 18 4	6 15 3½
1912.....	7 3 9	7 5 0	7 5 0	7 12 6	7 15 0	7 15 0	7 15 0	8 0 0	8 0 0	8 0 0	8 2 0	8 5 0	7 14 10
1913.....	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	7 19 0	7 15 0	7 3 0	6 15 0	6 10 0	7 16 5½
1914.....	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 0 0	6 0 0	7 0 0	7 5 0	7 5 0	7 6 3	7 10 0	6 14 8½
1915.....	8 0 0	8 10 0	9 0 0	9 10 0	9 10 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	10 5 0	11 0 0	9 12 11
1916.....	11 7 6	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 9 2
1917.....	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0
1918.....	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0
1919.....	11 10 0	14 0 0	14 0 0	14 0 0	17 0 0	17 7 6	17 15 0	18 5 0	18 5 0	18 5 0	19 12 6	21 5 0	16 15 5
1920.....	22 10 0	23 10 0	23 10 0	23 10 0	23 10 0	23 10 0	23 10 0	23 10 0	24 0 0	24 10 0	24 5 0	24 5 0	23 13 4
1921.....	23 5 0	22 10 0	20 4 0	19 0 0	19 0 0	17 0 0	15 0 0	14 15 0	13 12 0	12 5 0	10 10 0	10 10 0	16 9 3
1922.....	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 4 0	10 0 0	9 7 6	9 4 0	9 5 0	9 5 0	9 5 0	9 18 4½
1923.....	9 7 6	9 15 0	10 5 0	10 10 0	10 10 0	10 10 0	9 18 9	9 17 6	9 17 6	9 17 6	9 18 6	10 6 10½	10 1 2½
1924.....	10 1 6	9 18 1½	9 17 6	9 17 6	9 17 6	9 19 4½	10 5 0	10 5 0	10 5 0	9 19 0	9 15 0	9 15 0	9 19 7½
1925.....	9 14 0	9 10 0	9 10 0	9 1 3	9 0 0	9 0 0	8 17 0	8 13 1½	8 7 6	8 5 6	7 16 3	7 14 3	8 15 8½
1926.....	7 12 2½	7 12 6	7 12 6	7 14 4½	7 15 0	7 16 10½	8 2 6	8 2 6	8 4 0	8 12 6	8 16 3	8 1 1½	
1927.....	8 17 6	8 17 6	8 11 6	8 7 6	8 6 3	8 5 0	8 5 0	8 3 9	8 2 6	8 2 6	8 5 0	8 5 0	8 7 5
1928.....	8 2 6	8 5 0	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	—	—	—	—	—	—

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

PIG IRON

REGISTERED TRADE MARK

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

19, ST. VINCENT PLACE, GLASGOW.

ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENNTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED.

TO Foundries and Engineering Companies contemplating Reorganisation.—Successful Commercial Director, with experience in all foundry business (costing, accountancy, production, sales, range of specialities, etc.), is open to consider offers in an advisory capacity on such matters.—Write in confidence to Box 778, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

MANAGER wanted for Foundry making Ingot Moulds and Castings for general repairs of Steel Works Plant.—State age, experience and salary required, to Box 790, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY FOREMAN wanted, age 30-35, for modern Foundry, about end of September; only those need apply who have had experience with repetition work up to one ton; personal application preferred.—Higgs Motors, Witton, Birmingham.

PROPERTY.

FOR SALE BY AUCTION,
on Wednesday August 22nd, at 4 p.m., at
The "Bull Hotel," Royston,
EXCELLENT IRON & BRASS FOUNDRY.

Freehold Residence and Buildings; good scope; speciality Fire-bars, Plough Shares, Pig Troughs, etc.

For further particulars apply G. Scarborough Taylor, Auction Office, Buntingford. (Tel. 20).

11 ACRES WORKS SITE, SHEFFIELD.
145,000 Sq. Ft. of SHOPPING, Compact and Convenient.
SIDING CONNECTIONS
with L.M. & S. and L. & N.E. Rlys.
WELL-BUILT & COMMODIOUS OFFICES

Will Sell whole or in lots to suit customers, or Let on favourable terms. Unique opportunity for Manufacturers.

Apply—

THOS. W. WARD, LTD.,
ALBION WORKS, SHEFFIELD.

PUBLICATIONS.

Now ready. Exact Position To-day of Machinery with Regard to Rating.

RATING OF MACHINERY AND PLANT IN ENGLAND AND WALES, JULY, 1928. By John Scott Henderson, B.Sc. Lond., Barrister-at-Law. Price 5s.—"Rating and Income Tax," 1, Dr. Johnson's Buildings. Temple, E.C.4, or Argus Press, Tudor Street, E.C.4.

MACHINERY.

WANTED, Magnetic Separator, Rapid type, drum or tray pattern.—Box 788, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

REQUIRED, one second-hand Osborn Moulding Machine to take a Moulding Box 4-ft. square; must be cheap.—Box 784, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

MACHINERY.—*Continued.*

SAND MIXERS.—New and second-hand. Ask us to quote.—W. Brealey & Company, Limited, Prospect Works, Hawksley Avenue, Sheffield.

5-cwt. and 10-cwt. MASSEY Steam Hammers.

BRETT'S Steam Drop Stamps, up to 40 cwts. each.

CHURCHILL No. 2 Automatic Surface Grinding Machines.

No. 3 CINCINNATI Universal Cylindrical Grinding Machine.

2-ft. 6-in. gauge 4-wheel 7-in. LOCOMOTIVE (Bagnall), steel firebox, 150 lbs. W.P.

Six excellent HORIZONTAL DOUBLE-PURCHASE STEAM WINCHES (Clarke Chapman), cylinders 7-in. diam. x 10-in. stroke, 3 warping drums.

Three LANCASHIRE BOILERS, 30 ft. x 8 ft., reinsure 150 lbs. pressure.

Two dish-ended LANCASHIRE BOILERS, by Thompson, 30 ft. x 8 ft., reinsure for 150 lbs. per sq. in. working pressure.

CATALOGUE (10,000 Lots) ON APPLICATION.

THOS. W. WARD LTD.,
ALBION WORKS, SHEFFIELD.

PAIR of "Universal" type "A" Bonvillain Machines; equal to new; used few months only; £100 the two.—Hammond, 14, Australia Road, Slough.

SAND MIXERS AND CORE-MAKING MACHINES.—Ask for our quotation for new Machines; prices from £14 upwards. Write for List.

SULRON, LIMITED,
FOUNDRY ENGINEERS,
CLOISTER WORKS,
CONGRESS STREET, SHEFFIELD.

TILGHMAN Sandblast Room, 12 ft. x 9 ft., with compressor, separator and fan; little used; cheap to clear; space wanted.—Box 786, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

MISCELLANEOUS.

PURIC CUPOLA FLUX.—Now used by over 500 Foundries. Ask for special Puric Mailing Card, giving particulars. Send to-day for trial cwt. at 35s. per cwt., carriage paid.

BEECROFT & PARTNERS, LIMITED,
RETORT WORKS,
MAPPIN STREET, SHEFFIELD.

W.O. "PEERLESS" SPECIALITIES.—Fluxes for Brass, Gunmetal and Aluminium; Metallic Cement; Parting Powder, Liquid Core Sand Binder; all best and cheapest.

WILLIAM OLSEN, LIMITED,
COGAN STREET, HULL.

STRAW ROPES AND WAX CORE VENTS, as supplied and used by leading foundries. Buy from us and save money; cheapest and best.

SULRON, LIMITED,
FOUNDRY ENGINEERS,
CLOISTER WORKS,
CONGRESS STREET, SHEFFIELD.

CHARCOAL.—Best Hardwood, Lumps and Chips, quoted for carriage paid terms.

WILLIAM OLSEN, LIMITED,
COGAN STREET, HULL.

CARBEST POCKET MICROSCOPE, magnifies 25 times, Fountain Pen size, Cellulose finish, price 6s. 6d. each. Write to-day for yours. All Chemists should possess our Carbest List.

BEECROFT & PARTNERS, LIMITED,
RETORT WORKS,
MAPPIN STREET, SHEFFIELD.

MISCELLANEOUS.—*Continued.*

CHARCOAL.—Powdered, granulated, lump, blacking; inquiries invited.—J. Buchanan & Company, Ashfield Road, Altrincham, Cheshire.

GANISTER, best quality, for Cupolas, also for Steel Works.—Astbury Silica Company, "The Brooms," Park Lane, Congleton.

FOUNDRY REQUISITES

Try our REFRACTORIES.

Ganister or Silica Bricks and Blocks (any shape or size). **Sands, Cements, Ganister.**—*Let us have your enquiries*

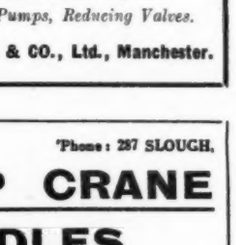
THE CLEVELAND MAGNESITE & REFRACTORY CO., LTD.
Normanby Brickworks, Normanby, Eston, Yorks.

ERITH YELLOW LOAM and SAND
FINEST QUALITY.

Quoted F.O.R. or D/D. to Customer's Station. *Enquiries esteemed.*

H & E. CRUNDALL, LTD.,
Foundry Supplies Dept.,
52, COAL EXCHANGE, LONDON, E.C.3.
Also
COKE and ALL FOUNDRY MATERIALS.

BAILEY'S
TRANSVERSE : TESTER :
FOR THE FOUNDRY.



Tests Bars of Cast Iron, Bronze, Etc.

Testers for all Materials, Oils, etc.
Air Compressors, Pumps, Reducing Valves.

SIR W. H. BAILEY & CO., Ltd., Manchester.

'Phone: 287 SLOUGH.

CHEAP CRANE LADLES

1 Ton latest type NEW	£18
3 Ton EVANS	£28
5 Ton EVANS	£36
8 Ton	£40
10 Ton	£42
15 Ton STEVENSON	£65

ALL HAVE WORM AND BEVEL GEARING

LARGEST STOCK OF FOUNDRY PLANT IN ENGLAND. PLEASE SEND FOR LISTS

BUY FROM ME AND SAVE MONEY.

ALEX. HAMMOND, *Foundry Machinery Merchant,*
14, AUSTRALIA ROAD, SLOUGH.